CHAPTER 8: MANUFACTURING IMPACT ANALYSIS

In accordance with the Energy Policy and Conservation Act, the U.S. Department of Energy (DOE) is currently in the process of revising the minimum energy-efficiency levels for the residential central air conditioner and heat pump product category. This report assesses the financial and employment impacts on manufacturers of these products due to a potential new efficiency standard.

8.1 MANUFACTURER IMPACT ANALYSIS METHODOLOGY

In determining whether a standard is economically justified, the Secretary of Energy is required to consider "the economic impact of the standard on the manufacturers and on the consumers of the products subject to such a standard." The legislation also calls for an assessment of the impact of any lessening of competition as determined in writing by the Attorney General. The purpose of the Manufacturer Impact Analysis (MIA) is to provide information that can be used to evaluate these impacts. The MIA estimates the financial impact of standards on manufacturers and reports impacts on employment and manufacturing capacity.

As proposed in the Department's rulemaking framework, we conducted the MIA in three phases. In Phase 1, the "Industry Profile", we gathered relevant industry data on market share, sales volumes and trends, pricing, employment, and financial structure. In Phase 2, we developed a "Industry Cash Flow" analysis for the industry subject to the various efficiency standards the Department is considering. In this phase, we adapted the Government Regulatory Impact Model (GRIM) to the residential unitary air conditioner industry to serve as the primary tool for the financial analysis. In Phase 3, the "Sub-Group Impact Analysis", we assessed impacts on a generic manufacturer of niche products and compressor manufacturers. Phase 3 also entailed documenting additional impacts on employment and manufacturing capacity.

8.1.1 Phase 1: Industry Profile

In Phase 1 of the MIA, we prepared a profile of the residential central air conditioner industry. Part of this work occurred during the Engineering Analysis as part of our estimation of markups and production costs. At that time, we collected market share, product shipment, and cost structure information for various manufacturers. Lawrence Berkeley National Laboratory (LBNL) also contributed information as part of their Life Cycle Cost and National Energy Savings analysis. The Preliminary Technical Support Document (TSD) accompanying the Supplementary Advance Notice of Proposed Rulmaking (SANOPR) presents much of the information we collected. In this report, we provide some additional information on the industry that was not presented in the preliminary TSD.

We relied on public sources for the industry profile. They included corporate financial reports submitted to the Securities and Exchange Commission (SEC 10-Ks), U.S. Census Bureau statistics, and trade publications.

8.1.2 Phase 2: Industry Cash Flow Analysis

The analytical tool used for calculating the financial impacts of standards on manufacturers is the Government Regulatory Impact Model (GRIM). In Phase 2, we adapted the GRIM to perform a cash flow analysis on the portion of the residential unitary industry devoted to the manufacture of the residential products.

For the Industry Cash Flow Analysis, we prepared a list of financial values for use in the GRIM. Publicly available financial statements of air conditioner manufacturers were the principle source of information. Prices were derived from the most recent reverse engineering production cost estimates and our estimates of typical manufacturer markups derived from financial reports and interviews with manufacturers. Shipments are consistent with those estimated for use in the National Energy Savings (NES) analysis.

8.1.3 Phase 3: Sub-Group Impact Analysis

During the course of the MIA, we visited and interviewed manufacturers representing over 90 percent of domestic residential unitary sales. We had previously visited many of the same companies as part of the Engineering Analysis. The MIA interviews shifted the discussion from technology-related topics to business-related topics. Our objective was to become familiar with each company's particular market approach and financial structure, and its concerns and issues related to new efficiency standards. The assumptions derived for use in Phase 2 helped us communicate and isolate those issues. The similarities and differences we noted between companies allowed us to characterize subgroups that we could then aggregate to represent the situation of the industry overall and refine the Phase 2 analysis.

8.1.3.1 Major Manufacturer Sub-Groups

In the course of our interviews, we realized that major manufacturers, who provide conventional unitary equipment to the mass market, take two distinct approaches to market. The first group attempts to keep operating expenses as low as possible and provides a lesser degree of service, support, marketing, and research. This group offers products that compete primarily on low price, targeted toward the new construction market and price-sensitive customers. They do not emphasize sales of higher efficiency equipment. The second group prefers to offer more substantial customer and dealer support and more advanced products. To cover these higher operating expenses, this group attempts to "sell-up" to more efficient products or products with features that consumers and dealers value. Both groups can exist within the same company as separate divisions, or even separate brands. New standards can impact manufacturers in these two groups differently because of the commoditizing effect that standards have on products, such as central air conditioners, whose predominant selling point is energy efficiency.

The GRIM we developed for Phase 2 is capable of assessing the financial impacts on each of these two sub-groups of major manufacturers.

8.1.3.2 Small Manufacturer Sub-Group

During the Engineering Analysis interviews, it became clear that manufacturers of niche air conditioning products faced special technological and financial considerations compared to those faced by the major air conditioner producers. Comments submitted to the Department after the release of the SANOPR reinforced our suspicion that new efficiency standards could be more detrimental to the financial situation of niche product manufacturers than the major manufacturers. In order to assess these impacts, we interviewed three niche manufacturers, focusing on the differences and similarities between their situation and that of the majors.

8.1.3.3 Compressor Supplier Sub-Group

The Department received comments urging them to consider impacts on compressor suppliers. Of all components in a residential unitary air conditioner, the compressor is the most specialized and the most responsible for the equipment's energy efficiency rating. It is also the largest contributor to the production cost. We asked compressor suppliers to ascertain whether they felt the new standards would place them at a particular competitive advantage or disadvantage. If so, the result could impact compressor prices and availability, which could have an indirect effect on equipment manufacturers and consumers.

8.2 INDUSTRY PROFILE

We developed a brief industry profile using information from relevant industry and market publications, industry trade organizations, company financial reports, and product literature. This industry characterization helped us estimate baseline retail and manufacturer prices and the industry cost structure, and to document financial information such as the industry average discount rate, tax rate, working capital, depreciation and capital expenditures. These values were used to develop a preliminary industry cash flow analysis. The industry characterization also aided in the development of a detailed and focused interview guide to perform the MIA.

8.2.1 Product Classes

Unitary products include air conditioners (cooling-only), heat pumps (cooling and heating), and furnaces (heating only). The rulemaking addresses only air conditioners and heat pumps. Air conditioners and heat pumps may consist of split systems and packaged products. A split system consists of an outdoor unit containing a compressor and condenser coil and a connected indoor unit containing an evaporator coil. The indoor unit may also include an electric, gas or oil heating section, an indoor blower system and associated controls. A packaged product is a single, self-contained unit with compressor, condenser, evaporator, blower and associated controls. Packaged equipment may also contain an electric, gas or oil heating section. They are typically installed on rooftops or beside a structure. Ducted air conditioners and heat pumps distribute conditioned air throughout building structures with ductwork connected to the system's blower, whereas ductless installations provide conditioned air directly from indoor blowers without the use of ductwork.

8.2.2 Market Shares and Distribution

Roughly 60 equipment manufacturers, several hundred distributors, and more than 30,000 dealers operate in the United States. Due to a wave of consolidation over the last 15 years, the top seven manufacturers now control 97 percent of the market share (Amana was acquired by Goodman in 1997 and International Comfort Products was acquired by Carrier in 1999). Most remaining small manufacturers produce only indoor coils or niche product lines. Table 8.1 shows the estimated market shares for each manufacturers from 1994 to 1998. Each manufacturer offers multiple brand names. Many of the brand names derive from once independent manufacturers that have been acquired by those who remain.

Most residential central air conditioning equipment passes through a two-step distribution chain: 1) manufacturer to distributor, and 2) distributor to dealer. Lennox uses one-step distribution (manufacturer to dealer) for its Lennox brand products and is the only notable exception. Trane also sells products through Sears and Home Depot. However, most industry members do not expect the trend toward one-step distribution to have a large effect on the market.

Table 8.1 Market Shares (%) in the Residential Unitary Industry (1987 - 1999)

	1987	1990	1994	1996	1998
Carrier	25	21	20	21	22
Goodman	*	7	15	16	17
Rheem	15	14	13	13	12
Trane	12	10	13	13	13
ICP [1]	**	**	11	10	9
York	8	8	7	9	7
Lennox	10	14	10	8	10
Nordyne	**	**	5	4	5
Amana [2]	3	3	3	3	3
Others	27	22	8	3	5

* not an independent entity
** included in "Others"
[1] Acquired by Carrier
[2] Acquired by Goodman
Sources: Appliance Magazine in SBI Market Profile: Air Conditioning Equipment, November 1997; Appliance Magazine September 1999

Equipment manufacturers sell most of their products directly to distributors (also called wholesalers.) Distributors sell to dealers at the distributor (wholesale) price. Distributors absorb short-term imbalances in supply and demand, allowing manufacturers to operate more efficiently and satisfying needs for fast deliveries. Distributors may specialize in HVAC equipment or may deal in other products. They are also important sources for lucrative after-market parts that boost margins. Distributors compete on price and service, although geographic boundaries and relationships prevent margins from being squeezed to commodity levels.

Most dealers compete at the local level. Many carry more than one brand, and most install the products they sell. Some are engaged in other contracting business, and most do commercial work. Dealers are consolidating rapidly in the wake of similar trends at the wholesale and manufacturer levels. There are now several large, national, publicly traded air conditioning dealers.

8.2.3 Sales

Sales and shipments of unitary AC products have increased considerably over the last decade. Unitary AC market sales in the U.S. have increased at an average rate of 5.6 percent between 1989 and 1996. This increase is related to periods of growth in replacement as well as growth in the prevalence of air conditioning installed in new residences. More and more, air conditioning is considered a basic feature, even in cooler regions, rather than a luxury item. Figure 8.1 provides industry value of shipments, industry dollar sales of unitary ACs, and exports and imports for the period 1992-1998. Notice that imports and exports declined in absolute and relative terms beginning in 1993 and have not recovered.

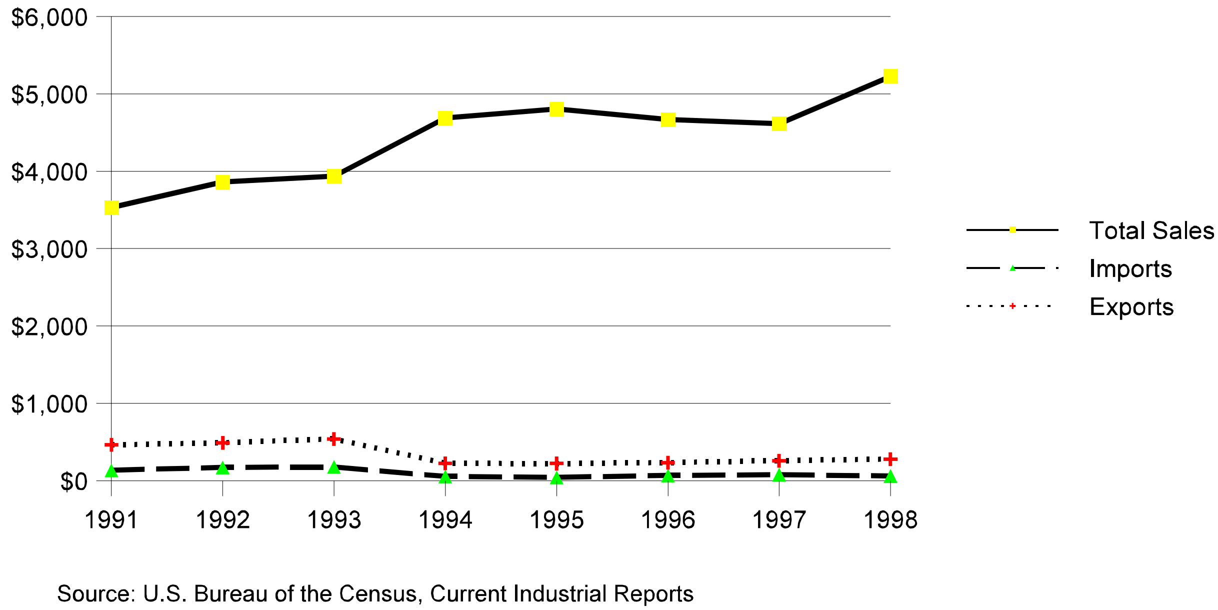

Figure 8.1 Value of All Unitary Shipments ($ million), 1991-1998

8.2.4 Price Trends

Price competition has a strong influence in the residential unitary air conditioner market since most end users perceive little difference among brands. A direct and consistent measure of air conditioner producer price changes is the Bureau of Labor Statistic's Producer Price Index (PPI) for unitary air conditioners (series ID PCU3585#2). The PPI measures quality-adjusted pricing in nominal dollars. The trend in PPI since 1989 is shown in Table 8.2. (The GNP deflator has been shifted to equal the PPI in 1993.)

Table 8.2 Historical Comparison of Unitary Air Conditioner Producer Price Index (PPI) and the U.S. Gross National Product Deflator

	Unitary Air Conditioner PPI (1)	Adjusted GNP Deflator (2)
1989	111.3	100.0
1990	114.8	103.9
1991	115.2	107.7
1992	113.6	110.3
1993	113.0	113.0
1994	113.3	115.4
1995	116.5	117.9
1996	119.6	120.1
1997	120.7	122.4
1998	123.8	123.8
1999	126.7	125.6

(1) Series PCU3585#2
(2) Scaled to equal the PPI in 1993.
Source: U.S. Department of Commerce

Prices are influenced by many factors. In the case of central air conditioners, weather seems to play a strong role in the short term. For example, the rapid increase in annual average PPI from 1997 to 1998 corresponds to a sudden price increase that occurred during the summer of 1998 when the monthly PPI increased from 120.4 to 128.2 from May to September. That year there was the most intense El Nino weather phenomenon ever recorded and periods of unusually hot weather occurred throughout the country. In September 1999, the PPI dropped from 128.1 to 123.4, while the GNP deflator continued its steady rise. From 1993 to 1999, the real increase in unitary air conditioner PPI is less than 0.2 percent per year as measured by average annual PPI and GNP deflator. In detail the picture is more complicated, but the price fluctuations are as big as any real price trends during this period. This means that there is significant uncertainty in forecasting recent price trends into the future.

8.3 GRIM INPUTS AND ASSUMPTIONS

The Government Regulatory Impact Model (GRIM) served as the main tool for assessing the impact on industry due to the imposition of new efficiency standards. We relied on several sources to provide inputs to the GRIM in the form of data and assumptions. The GRIM's accounting methods then produce the results used to describe impacts on manufacturers.

8.3.1 Sources of GRIM Inputs

SEC 10-Ks

Corporate annual reports to the Securities and Exchange Commission (SEC 10-Ks) provided the bulk of the financial inputs to the GRIM. These reports exist for publicly held companies, and are freely available to the general public. The 10-Ks provide consistent and reliable financial data for the consolidated corporation but do not provide detailed financial information for the company's residential unitary business line. Some 10-K's are therefore more relevant than others to the analysis of the residential unitary industry depending on the prominence that business has in the company's overall operations. In determining financial parameters for the industry, we weighted corporate financial information contained in the 10-Ks by each company's market share in residential unitary products.

10-Ks provided the following GRIM inputs:

- tax rate
- working capital
- sales, general, and administration expenses (SG&A)
- research and development expenses (R&D)
- depreciation
- capital expenditures
- net property, plant, and equipment.

We also used 10-Ks to calibrate the GRIM's operating profit margin against the weighted industry average.

When possible, we used independent reports from such sources as www.globalbb.onesource.com to simplify our collection of 10-K information.

Moody's Investor Services

Moody's provides independent credit ratings, research and financial information. Moody's reports are available for a nominal fee. We relied on Moody's reports to determine the industry's average cost of debt for our cost of capital calculation.

Shipments Model

The shipment projections for the analysis came from the Department's shipments model described in Chapter 6.

Air-conditioning and Refrigeration Institute (ARI)

ARI is the trade organization that represents the unitary air conditioning industry. ARI provided two pieces of information: the distribution of products by efficiency level as of 1994, and the relative production cost of products under new efficiency standards.

ARI no longer makes sales-by-efficiency information available to non-members. Since shipment weighted efficiencies have not changed much since 1994, and after reviewing the current distribution provided to us by one of ARI's members, we assumed that this distribution continues to apply today.

The cost multipliers ARI provided relate the cost of producing baseline equipment under new standards to the cost of producing baseline equipment under today's standards. According to ARI, the multipliers account for changes in indirect costs and investments as well as in direct costs. We used the Mean cost multipliers in the GRIM analysis.

Reverse Engineering

During the Engineering Analysis, we performed a technology-based cost estimation on 3-ton air conditioners and heat pumps. The analysis provided labor, materials, and overhead production costs for each product class.

Interviews

During the course of the Engineering Analysis and MIA, we visited 11 manufacturers of complete air conditioning systems, one manufacturer of indoor units and coils, and four compressor and motor suppliers. During those visits, we discussed financial and strategic topics specific to each company. Most of the information received from these meetings is protected by non-disclosure agreements and reside with our contractor.

Before each visit, we provided company representatives with a formal interview guide that included the topics we hoped to cover. For the MIA, two versions were produced. The first applied to major manufacturers and was sent to six firms. The second applied to low volume manufacturers and was sent to two firms. The topics included:

- *Cost structure* – fraction of labor, materials, operating expenses, working capital, etc.
- *Shipment projections* – degree of agreement with Department projections
- *Product mix* – sale volumes by efficiency level and projections under new standards
- *Overall profitability* – profitability versus corporate average
- *Profitability by efficiency level*
- *Replacement parts* – contribution to revenues and profits
- *HCFC phaseout and other regulations* – impacts on designs and cumulative burden

- *Exports* – impacts of new standards on export sales and revenues
- *Conversion costs* – estimates of costs required to meet new standards
- *Consolidation* – reasons for, and projections of, continued mergers
- *Niche products* – whether any niche products would be impacted
- *Effective date of standards* – whether the 5 year lead time contributes to additional burden
- *Fractional standard levels* – whether standard levels other than whole integers would add to the impacts
- *HSPF-SEER* – impacts associated with proposed HSPF-SEER pairings and possible differences between SEER requirements

We often introduced, entertained, and discussed other topics during the course of the interviews.

Niche product manufacturers received a different version of the interview guide. It covered the same topics, but focused on the differences between their situation and that of the larger manufacturers. We did not use a formal interview guide during our conversations with compressor manufacturers regarding the MIA. We focused exclusively on whether they expected new efficiency standards to place them at a particular competitive advantage or disadvantage.

The information we gathered from the interviews helped us adapt the GRIM to reflect the realities of the residential unitary industry as well as to provide qualitative assessment of topics that we cannot represent adequately in the GRIM.

8.3.2 Overview of the GRIM

The basic structure of the GRIM, illustrated in Figure 8.2, is a standard annual cash flow analysis that uses manufacturer price, manufacturing costs, shipments and industry financial information as an input, and accepts a set of regulatory conditions as changes in costs, investments and associated margins.

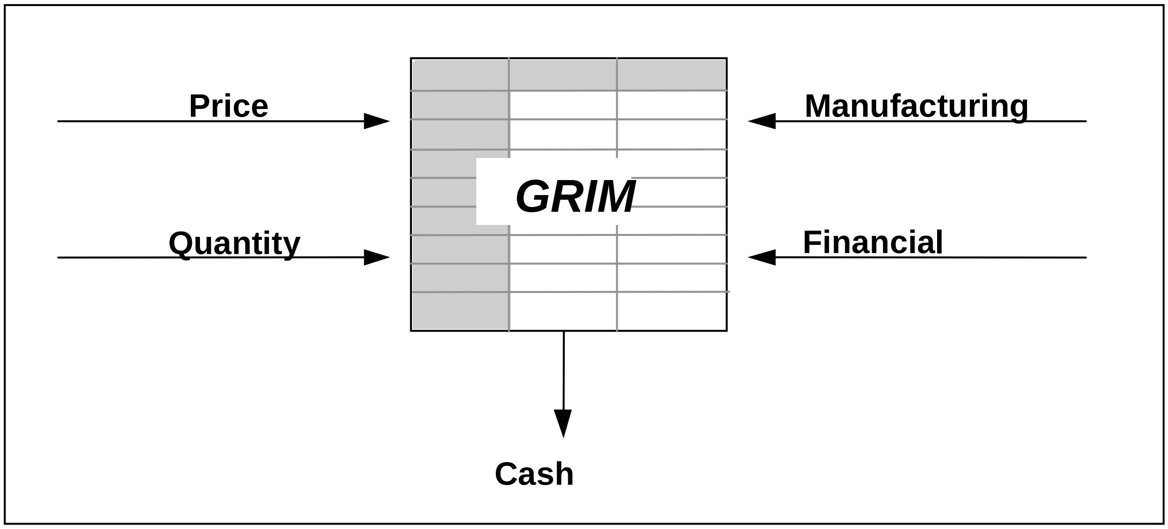

Figure 8.2 Using the GRIM to Conduct the Cash Flow Analysis

The GRIM spreadsheet uses a number of inputs to arrive at a series of annual cash flows, beginning from the base year of the analysis and continuing explicitly for ten years after the implementation of the standard. The measure of industry net present value (INPV) is calculated by summing the stream of annual discounted cash flows and adding the discounted value of the industry at the end of the ten-year period (see Section 8.4.4.).

The GRIM calculates cash flows by year using standard accounting principles, and then determines the present value of net cash flows, both without regulations (Base Case) and with regulations (Standard Case), using a discount rate based on the industry's weighted average cost of capital. For the purpose of this analysis, the Base Case scenario represents the business scenario in the absence of a new standard. In case a new standard comes into effect, it will change the product mix and the associated prices, costs, and shipments. Such a scenario is called the Standard Case scenario. The difference in INPV between the two scenarios becomes the financial impact of the new standard under consideration.

8.3.3 Financial Parameters

Table 8.3 provides financial parameters for five public companies engaged in the manufacturer and sale of unitary air conditioners averaged over a five year period (1994-1998). The values used in the GRIM are generally the average of those results as weighted by the product of each manufacturer's corporate revenues and unitary market share. Companies generally confirmed that these values are applicable for the analysis of their residential unitary business lines.

Table 8.3 GRIM Financial Parameters Based on 1994-1998 Weighted Company Financial Data

Parameter	Industry Weighted Average	Manufacturer A	B	C	D	E
Tax Rate (% of taxable income)	45.4%	84.8%	--	39.4%	33.6%	33.3%
Working Capital (% of revenues)	9.4%	-4.0%	18.0%	22.0%	8.0%	15.0%
SG&A (% of revenues)	16.1%	16.4%	15.1%	19.8%	16.5%	14.1%
R&D (% of revenues)	2.6%	2.7%	0.5%	0.9%	4.6%	0.9%
Depreciation (% of revenues)	2.6%	2.1%	2.4%	2.1%	3.6%	1.5%
Capital Expenditures (% of revenues)	2.9%	3.5%	2.5%	2.0%	3.4%	1.8%
Net Property, Plant, and Equipment (% of revenues)	15.0%	18.0%	5.0%	16.0%	18.0%	11.0%

Source: SEC 10-K Reports, Fiscal Years 1994-1998

8.3.4 Corporate Discount Rate

We assumed that the discount rate for use in calculating the INPV is equal to the weighted average cost of capital (WACC) for the industry. A company's assets are financed by a combination of debt and equity. The WACC is the total cost of debt and equity weighted by their respective proportions.

For the *cost of debt*, Moody's Investor Services provided us with the average spread of corporate bonds for each of the five public manufacturers over the 30 year T-Bill from 1990-1998. We then added the industry weighted average spread to the average T-Bill yield over the same period. Since we assume that proceeds from debt issuance are tax deductible, we reduced that gross cost of debt by the industry average tax rate to determine a net cost of debt for the industry of 5.7 percent. Table 8.4 presents the derivation of the cost of debt.

Table 8.4 Cost of Debt Calculation

Parameter	Industry Weighted Average	Manufacturer A	B	C	D	E
(***1***) Spread over 30 year T-Bill (%)	3.2%	5.5%	9.8%	3.7%	1.5%	2.1%
(***2***) Yield on 30 year T-Bill (1990-1998)	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%
(***3***) Gross cost of debt (***1***+***2***)	10.4%	12.7%	17.0%	10.9%	8.7%	9.3%
(***4***) Tax Rate	45.4%	85.0%	--	39.0%	34.0%	33.0%
Net Cost of Debt (***3****(1-***4***))	5.7%	1.9%	--	6.7%	5.8%	6.3%

Source: SEC 10-K Reports, Fiscal Years 1994-1998

The *cost of equity* is the rate of return that equity investors (including, potentially, the company) expect to earn on a company's stock. These expectations are reflected in the market price of the company's stock. The capital asset pricing model (CAPM) provides one widely used means to estimate the cost of equity.

According to the CAPM, the cost of equity (expected return) is:

Cost of equity = riskless rate of return + beta * risk premium

where:

Riskless rate is the rate of return on a "safe" benchmark investment, typically considered the short term T-Bill yield.
Risk premium is the difference between the expected return on stocks and the riskless rate
Beta is the correlation between the movement in the price of the stock and that of the broader market. In this case, the Beta equals 1 if the stock is perfectly correlated with the S&P 500 market index. A Beta lower than 1 means the stock is less volatile than the market index.

We determined that the industry average cost of equity is 14.7 percent as calculated in Table 8.5.

Table 8.5 Cost of Equity Calculation

Parameter	Industry Weighted Average	Manufacturer				
		A	B	C	D	E
(***1***) Average Beta (1994 - 1998)	1.07	0.87	0.88	0.67	1.37	0.83
(***2***) Yield on 10 year T-Bill (1990-1998)	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%
(***3***) Risk premium of 10 year T-Bills over short term government bonds	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
(***4***) Risk-free rate of return (***2*** - ***3***)	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%
(***5***) Stock market risk premium (1935 - 1998)	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%
Cost of Equity (***4*** + ***1*** * ***5***)	14.7%	13.0%	13.1%	11.3%	17.2%	12.7%

Source: SEC 10-K Reports, Fiscal Years 1994-1998

The WACC is then, 0.057 (cost of debt) * 0.59 (debt ratio) + 0.14 (cost of equity) * 0.41 (equity ratio), or 9.3 percent. Subtracting an inflation rate of 3.1 percent between 1990 and 1998, the inflation adjusted WACC, and the corporate discount rate used in the GRIM, is 6.2 percent.

8.3.5 Shipments

We took the shipment projections directly from the National Energy Savings (NES) model's outputs (Chapter 6). They provided the shipments (in units sold annually) of each product class at efficiency levels 10 SEER through 18 SEER through 2030 under three different scenarios. The scenarios were:

NAECA — a reproduction of the effects that the NAECA standard had on the industry efficiency mix in 1992. This is the default scenario.

Shift — a translation of all products to the next highest efficiency level for each level of increase in the standard. This is an optimistic scenario that assumes that demand for a high efficiency product is a function of the differential between its efficiency and the standard level.

Rollup — a translation of only those products below the new efficiency standard to the new standard level. This is a pessimistic scenario that assumes that demand for a high efficiency product is a function of its price without regard for the standard level.

Manufacturers uniformly agreed that the projected growth rates and the projected drop in shipments in the year following the imposition of the new standard were reasonable. However, they were divided on which product mix scenario would most likely occur. The consensus seemed to be that customers do not, and will not, purchase products that fall within 20 percent (about 2 SEER points) above the standard level because the energy savings are not enticing enough to cause them to upgrade. Furthermore, manufacturers argue that there is a technological limit between 14 SEER and 15 SEER, preventing the Shift scenario from occurring fully. Also, since prices escalate faster than do energy savings as efficiency rises, consumers will look for an even larger SEER differential in order to justify an upgrade. This reasoning implies that overall, manufacturers may believe that the Shift scenario is likely to occur under an 11 SEER standard, but that the NAECA or Rollup scenarios (or even a collapse of all sales to the new standard level) are the more probable scenarios under a 12 SEER standard or above.

Since the efficiency scenario is an important determinant of manufacturer impact, Section 8.4.8 provides a more complete assessment of conditions that affect the likelihood of a particular scenario actually occurring.

8.3.6 Production Costs

Changes in revenue and gross profit are driven by changes in production cost. As shown in the Engineering Analysis, more efficient products cost more to produce. For the MIA, we adopted the 10 SEER production costs resulting from the reverse engineering analysis. As we raised the standard level, we calculated the production costs of the new baseline units as the product of the 10 SEER reverse engineering-based cost and the appropriate relative cost multiplier from either the ARI Mean or reverse engineering sets of multipliers, depending on the scenario. To avoid double-counting amortized investment cost, we lowered the ARI multipliers by an amount equal to our estimated amortized investment, which is then reapplied elsewhere in the GRIM.

We also estimated the production cost of non-baseline (higher efficiency) equipment using the same multipliers. For example, we estimated the cost of a 12 SEER unit today as the product of the 10 SEER reverse-engineering cost and either the 12 SEER ARI or reverse engineering multiplier for 12 SEER.

Besides the total unit production cost, the GRIM requires the proportion of costs devoted to labor, materials, and overhead. Again, we used reverse engineering results to derive those fractions. To avoid double-counting, the costs do not include outbound freight charges or depreciation. (We assume that any changes in outbound freight are captured in ARI's relative cost multipliers, and the GRIM models changes in depreciation.) The GRIM assigns outbound freight to SG&A and depreciation to its own line item. This means that the costs appear lower than those resulting from reverse engineering, which included outbound freight charges and depreciation. However, since the markups are also different, the prices to the distributor are comparable.

For split air conditioners, we combined units with fancoils and units with cased coils by taking the arithmetic average of the two costs.

Tables 4.7 and 8.6 provide the production cost assumptions we used in the GRIM.

Table 8.6 Production Costs Used in the GRIM Analysis

Efficiency Level (SEER)	Split Air Conditioner	Packaged Air Conditioner	Split Heat Pump	Packaged Heat Pump
10 SEER Cost	$369	$445	$520	$526
Materials	85%	79%	81%	81%
Labor	7%	7%	7%	7%
Overhead	8%	14%	12%	12%

Note: Unlike the table presented in the NOPR, GRIM costs do not include outbound freight or depreciation, which are included in the GRIM's manufacturer markup.

8.3.7 Markups

To derive the price of the equipment sold, we developed markups that the GRIM applies to the production costs resulting from Tables 8.6 and 4.7. We assumed the markups were the same across product classes, but not necessarily the same across efficiency levels. We then adjusted the markups until the GRIM produced a base case operating profit of 6 percent, equal to the industry average.

We confirmed during our interviews that a company's markups reflect its pricing strategy. Some companies said their markups were the same across all residential products, some said they were the same within a product line, and some said they increased with efficiency. Since the markup issue is among the most important determinants of the impacts of a new standard on a company's finances, we modeled two types of companies (Section 8.1.3.1). The first type prices equipment similarly across efficiency levels and brands. Manufacturers in this group typically have below average operating costs. Markups for this group stay "flat" as efficiency increases. The second type prices baseline equipment aggressively, but applies larger markups to premium and higher efficiency products. Manufacturers in this group typically have higher operating costs than the first group. Markups for this group are "linearly increasing" as efficiency increases. We will discuss this concept more in Section 8.4.3.

Table 8.7 presents the markups for the two groups. The markups for the higher operating cost group are relative to the baseline at the time. For example, under the current 10 SEER standard, the markup on a 12 SEER would be "Base + 2", or 1.50. If the standard were to increase to 11 SEER, the markup at 11 SEER would become the new "Base", or 1.36, and the markup at 12 SEER would become "Base +1", or 1.43.

Table 8.7 Manufacturer Markups Used in the GRIM

Efficiency Level	Lower Operating Cost Manufacturers	Higher Operating Cost Manufacturers
Base	1.31	1.36
Base + 1	1.31	1.43
Base + 2	1.31	1.50
Base + 3	1.31	1.57
Base + 4	1.31	1.65
Base + 5	1.31	1.74

Differences between the GRIM and Engineering Analysis explain the apparent differences in markups on baseline equipment (the manufacturer markup in the Engineering Analysis is 1.23–see Section 4.3.2). The GRIM markups include the 6 percent freight and 2.6 percent depreciation that were included in reverse engineering production costs rather than in the Engineering Analysis markups, and 4 percent higher operating profit margins. Also, the GRIM does not provide for interest expenses, so Earnings Before Taxes (EBT) and Earnings Before Interest and Taxes (EBIT) are indistinguishable. Thus, it is not possible to calibrate the GRIM exactly using corporate financial statements which do include interest expense. Since the Engineering and MIA analyses address separate issues, slight discrepancies between the two markups are not of concern.

We experimented with lowering the markups as the standard level increased to represent a situation where pricing pressure prevents manufacturers from reestablishing their markups under new standards. However, we found that doing so in a way that maintained their operating profit margins made little difference to the overall conclusions.

8.3.8 Conversion Costs

Table 8.8 provides the capital and non-capital expenses used in the GRIM at each efficiency level. One of our major objectives during the manufacturer interviews was to determine the level and types of investment the companies expected to incur to comply with a new efficiency standard. The major costs they identified were those associated with capacity and warehouse expansion and development and testing.

Although the shipment projections call for sales volumes to decrease after a new standard is promulgated, manufacturers contend that as efficiency increases, the size of the products and the time required to fabricate and assemble them also increase. The Engineering Analysis concurs with their assessment. Since manufacturing capacity in the industry is currently strained, a standard-induced drop in throughput will result in a shortage unless manufacturers add capacity.

Table 8.8 Summary of Industry-wide Conversion Cost Assumptions used in the GRIM ($ million)

Standard Level (SEER)	Split Air Conditioner	Packaged Air Conditioner	Split Heat Pump	Packaged Heat Pump	Total
Capital					
11	$11	$8	$8	$7	$34
12	$54	$14	$23	$10	$101
13	$99	$21	$38	$12	$171
Non-Capital					
11	$15	$15	$15	$15	$61
12	$31	$30	$31	$30	$121
13	$46	$45	$46	$45	$182
Total					
11	$26	$23	$23	$22	$95
12	$85	$44	$54	$40	$222
13	$145	$66	$84	$57	$353

From a development and testing standpoint, most manufacturers employ engineers and testing personnel on staff and maintain their own testing facilities. However, inadequate testing facilities represent a bottleneck in the product development cycle for many firms. In order to develop products to comply with a new standard, manufacturers will have to dedicate their design staffs and testing facilities almost exclusively to the new products, leaving few remaining resources to conduct their ordinary product development and testing efforts. Furthermore, since all new products must be tested rigorously before certification, the costs of testing mount up quickly. This burden increases as the standard level rises, since more products are affected and more substantial design alterations are required.

The GRIM treats capital investments differently from non-capital investments. Capital investments include modifications or additions to plant, property, and equipment that increase its useful life. Capacity increases and new tooling are capital expenditures, which the GRIM amortizes over a five year period. Non-capital expenses, such as marketing and R&D, are expensed in the year in which they are incurred. The following two sections explain in more detail the derivation of the assumptions presented in Table 8.8.

8.3.8.1 Capital Expenditures

Manufacturers provided us with information during the manufacturer interviews that allowed us to estimate the capital expenditures associated with new efficiency standards. They include additions to plant capacity and warehouse space. We derived estimates for a typical company holding a 14 percent market share.

Since higher efficiency products are larger and heavier than today's 10 SEER equipment, each unit takes slightly longer to produce. Coils and cabinets are larger, requiring longer fabrication, assembly, and charging times. The density of units on the assembly line is lower, reducing the throughput in the processes that require a minimum residence time per unit such as painting and leak testing. Handling the more cumbersome equipment takes additional care. Due to the recent surge in air conditioner sales, most manufacturers face some sort of capacity constraint which more stringent efficiency standards will exacerbate. In order to continue to satisfy demand, we assumed that new standards would trigger manufacturers to improve productivity or add capacity to recuperate their lost production capacity.

The model used to estimate production costs in the reverse engineering analysis also estimates product cycle times. According to the model, cycle times will increase 0 percent under an 11 SEER standard, 2 percent under a 12 SEER standard, and 7 percent under a 13 SEER standard. Below 12 SEER, we would not expect standards to prompt manufacturers to invest in capacity. At 12 SEER and 13 SEER, however, we estimate each manufacturer will spend $6 million and $14.5 million to upgrade capacity, respectively. These expenditures are equivalent to 50 percent and 125 percent of the annual ordinary capital expenditures incurred by a typical firm, according to the GRIM. These sums would include costs associated with the purchase and installation of new equipment, including modifications or additions to the existing plant.

Larger equipment not only implies reduced production capacity, it implies reduced warehouse capacity. Since manufacturers must store the incoming and outgoing materials and equipment, any increase in the volume of components or the size of the assembled equipment will require more storage space. We assumed that manufacturers face warehouse storage constraints that they cannot mitigate by reducing the number of units in inventory. Therefore, new standards that increase the size of the product will result directly in a need for new warehouse floorspace.

The reverse engineering analysis provides information on equipment cabinet sizes for each efficiency level. The increase in size for 11 SEER, 12 SEER, and 13 SEER condensing units and cased coils is 0.8 cu. ft., 7.7 cu. ft. and 12.1 cu. ft., respectively. We then assumed that the extra floorspace required to store each unit equals the extra volume of the unit raised to the two-thirds power. That yields additional floorspace requirements of 0.9 sq. ft., 3.9 sq. ft., and 5.3 sq. ft., respectively. This method should accurately estimate new floorspace requirements if the height of a stack of units in the warehouse remains fixed. Finally, we assumed that warehouses are sized to accommodate an inventory of 12,000 units (one-tenth the annual production of 120,000 units used in the GRIM) and that new warehouse floorspace costs $100 per square foot to construct and integrate with existing facilities.

New tooling is also a capital expenditure. We assumed that new tooling would cost $500,000 per product family, regardless of the standard level. The implicit assumption is that any new standard will result in the need for new tooling. We assume that a typical firm possesses two product families in each product class.

Table 8.9 summarizes the capital expenditure assumptions.

Table 8.9 Capital Expenditures used in the GRIM (million 1999$)

Standard Level (SEER)	Capacity Additions	Warehouse Additions	New Tooling	Total
Capital Expenditures per Company				
11	$0.0	$0.9	$4.0	$4.9
12	$6.0	$4.4	$4.0	$14.4
13	$14.5	$6.0	$4.0	$24.5
Resulting Capital Expenditures for the Industry (seven companies)				
11	$0	$6	$28	$34
12	$42	$31	$28	$101
13	$102	$42	$28	$172

Finally, in order to fit capital expenditures into the GRIM framework, we allocated the totals to each product class based on the fraction of sales volume attributable to that class. Table 8.10 illustrates those breakdowns by product class.

Table 8.10 Industry-wide Capital Expenditures by Product Class used in the GRIM (million 1999$)

Standard Level (SEER)	Split Air Conditioner	Packaged Air Conditioner	Split Heat Pump	Packaged Heat Pump	Total
Fraction of Sales Volume	*65%*	*10%*	*22%*	*4%*	*100%*
11	$11	$8	$8	$7	$34
12	$54	$14	$23	$10	$101
13	$99	$21	$38	$12	$171

Note: Differences in Totals from those in Table 8.9 are due to rounding.

8.3.8.2 Non-capital Expenditures

Non-capital expenditures such as product development, testing, and marketing depend on the number of a company's products that are affected by the new standard. We assumed that a typical company's product offering consists of two product families in each product class, that each split system family consists of three product lines, and that each packaged family consists of two product lines. That results in a total of eight product families and 20 product lines that could be affected by a new standard for a typical major manufacturer.

Based on input we received during the interviews, we considered the testing, development, and marketing expenditures related to a new standard. We assumed that testing and development expenses scale with the number of product families affected and marketing expenses scale with the number of product lines affected, and that they also increase linearly with an increase in standard level. Table 8.11 provides our assumptions regarding non-capital expenditures.

Table 8.11 Non-capital Expenses used in the GRIM

Category	Split Air Conditioner	Packaged Air Conditioner	Split Heat Pump	Packaged Heat Pump	Total
Product Family Expenses					
*(**1**) Number of Product Families*	*2*	*2*	*2*	*2*	*8*
(***2***) Testing Expense per Family ($ thousand)	$333				
(***3***) Development Expense per Family ($ thousand)	$667				
(***4***) Total Testing and Development Expenses (***1***) x (***2***+***3***) ($ million)	$2.0	$2.0	$2.0	$2.0	$8.0
Product Line Expenses					
*(**5**) Number of Product Lines per Family*	*3*	*2*	*3*	*2*	*n/a*
*(**6**) Number of Product Lines*	*6*	*4*	*6*	*4*	*20*
(***7***) Marketing Expenses per Product Line ($ thousand)	$33				
(***8***) Total Marketing Expenses (***5*** x ***6*** x ***7***) ($ million)	$0.2	$0.1	$0.2	$0.1	$0.7
(*9*) Total Non-Capital Expenses per Firm (*4* + *8*), ($ million)	$2.2	$2.1	$2.2	$2.1	$8.7
Total Industry Non-Capital Expenses (*9* x 7 firms), ($ million)	$15.4	$14.9	$15.4	$14.9	$60.6

8.4 INDUSTRY FINANCIAL IMPACTS

Using the GRIM inputs and assumptions described in the previous chapter, the GRIM produced indicators of financial impacts on the residential unitary equipment manufacturing industry. We are reporting three of these:

- Net Present Value
- Return on Invested Capital
- Annual Cash Flow

8.4.1 Scenarios

The GRIM results depend strongly the mix of product efficiencies assumed under new standard levels. There are three efficiency scenarios as described in 8.3.5:

1) *NAECA*
2) *Shift*
3) *Rollup*

In addition to the scenarios that describe efficiency mix, there are two scenarios that describe production costs:

1) *ARI manufacturing cost* — a set of production cost estimates based on the product of the mean relative production cost multipliers provided to the DOE by ARI and the costs for 10 SEER equipment estimated by reverse engineering. This is the default scenario.
2) *Reverse engineering cost* — a set of production cost estimates based on reverse engineering analysis. This scenario was evaluated only in conjunction with the NAECA shipment scenario to isolate the effects of the cost assumptions on the results.

Finally, there are two scenarios that describe the life of the product. Product lifetime has a direct impact on the shipment projections provided to the GRIM:

1) *18 year lifetime* — assumes an 18.4 year product life with a compressor replacement at 14 years. This is the default assumption.
2) *14 year lifetime* — assumes a 14 year lifetime based on anecdotal evidence and comments of various industry members and groups. This scenario was evaluated only in conjunction with the NAECA shipment and ARI manufacturing cost scenarios to isolate the effects of the product lifetime assumption on the results.

In summary, we estimated the impacts on the industry under five combinations of scenarios as shown in Table 8.12:

Table 8.12 Scenarios Evaluated in the MIA

	Efficiency Scenario	Production Cost Scenario	Product Life Scenario
1.	NAECA	ARI	18 years
2.	SHIFT	ARI	18 years
3.	ROLLUP	ARI	18 years
4.	NAECA	Reverse Engineering	18 years
5.	NAECA	ARI	14 years

The first three scenarios express the range of possible outcomes using the ARI Mean cost multipliers and 18 year lifetime assumptions. The likelihood of each scenario developing depends on market conditions, access to new technologies, and the standard level set. We explore this further in Section 8.4.8.

The last two scenarios evaluate the implications of using the reverse engineering relative costs or a 14 year product life instead of the ARI Mean relative costs and 18 year product life.

8.4.2 Trial Standard Levels

We evaluated industry impacts at each of four Trial Standard Levels (TSLs). The four we evaluated are shown in Table 8.13:

Table 8.13 SEER Requirements for Product Classes in the Trial Standard Levels Evaluated in the MIA

Trial Standard Level	Split Air Conditioners	Packaged Air Conditioners	Split Heat Pumps	Packaged Heat Pumps
1	11	11	11	11
2	12	12	12	12
3	12	12	13	13
4	13	13	13	13

The Department also considered a TSL 5 to include the Max Tech level of 18 SEER for all classes. We did not evaluate TSL 5 in the MIA since consumer impacts rendered it economically unjustified prior to the start of the MIA.

8.4.3 Manufacturer Subgroups

As we introduced in Section 8.1.3.1, the interviews revealed that manufacturers use different pricing strategies and place different levels of emphasis on the sale of higher efficiency products. Manufacturers fall into two basic groups in this regard. The first group targets price-sensitive consumers such as builders and price-sensitive consumers and attempts to keep operating costs, such as sales and marketing, research and development, and dealer support as low as they can sustain. They also reduce the number of product variations and features. This approach to market limits the ability and desire of this group to sell premium equipment and equipment above the minimum efficiency level. Because they have a cost advantage over their competitors, these manufacturers can establish a higher operating profit margin on their baseline equipment and still maintain a price advantage. They then apply a fairly consistent gross margin across efficiency levels. We use the phrase “lower operating cost” manufacturers to describe this group.

The other group, the “higher operating cost”, manufacturers typically place more of an emphasis on product differentiation than cost leadership. Achieving successful differentiation often requires a combination of marketing, service, research, and product development that exceeds that of the lower operating cost manufacturers. Faced with stiff price competition from the lower operating cost manufacturers in price-sensitive markets, the higher operating cost manufacturers are forced to reduce their price (and gross margin) on their baseline equipment to the minimum level sustainable. They then target less price sensitive customers by offering products with premium features and higher efficiency. These products carry higher gross margins.

Since higher efficiency standards will affect each group of manufacturers differently, we set up two versions of the GRIM to model each group independently. In the first group, to represent the lower operating cost manufacturers, we slightly reduced the operating expense ratio and research and development expense ratio below the industry averages. We also assumed that a single gross margin applies to products across all efficiency levels. In the second group, to model higher operating cost manufacturers, we raised operating and R&D expense ratios above the industry average. We then assume that gross margins increase roughly linearly as the efficiency level increases. This represents two effects: selling a greater fraction of higher margin premium product as efficiency level rises, and being able to secure a higher margin on product simply by virtue of its higher efficiency.

To represent the industry in aggregate, we combined the results of the two GRIM versions, giving 25 percent weight to the results of the lower-operating-cost group and 75 percent weight to the results of the higher-operating-cost group. This ratio reflects the prevalence of each strategy in the marketplace. Many companies pursue both strategies simultaneously through different brands and divisions.

Section 8.5.1 discusses the differences in the two GRIMs in more detail.

8.4.4 Impacts on Industry Net Present Value (INPV)

INPV is an important indicator of the value of the entire industry. It is not to be confused with the Department's NPV applied to the whole U.S. economy. By comparing the base case (no new efficiency standard) to each standard case, we can isolate the effects that a new standard is likely to have on the industry's value. INPV is calculated as the sum of all discounted net cash flows between 2000 and 2016 (ten years after the new standard would become effective) plus the discounted terminal value of the industry in 2016. The value of the industry in 2016 is simply the net cash flow in that year divided by the discount rate. If net cash flow drops either due to a drop in net income or an increase in depreciation or capital investment, INPV will also drop.

Tables 8.14 through 8.16 provide the net present value estimates for the industry. These results supercede any others previously published.

Table 8.14 Changes in Industry Net Present Value — Industry Relative Cost, 18 Year Life, NAECA Efficiency

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,603	--	--
1	$ 1,566	$ (37)	-2%
2	$ 1,417	$ (186)	-12%
3	$ 1,406	$ (197)	-12%
4	$ 1,420	$ (183)	-11%

Table 8.15 Changes in Industry Net Present Value — Industry Relative Cost, 18 Year Life, Roll-up Efficiency

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case $ million	Change in NPV from Base Case %
Base	$ 1,603	--	--
1	$ 1,422	$ (181)	-11%
2	$ 1,241	$ (362)	-23%
3	$ 1,236	$ (367)	-23%
4	$ 1,268	$ (335)	-21%

Table 8.16 Changes in Industry Net Present Value — Industry Relative Cost, 18 Year Life, Shift Efficiency Mix

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case $ million	Change in NPV from Base Case %
Base	$ 1,603	--	--
1	$ 1,740	$ 137	9%
2	$ 1,825	$ 222	14%
3	$ 1,854	$ 251	16%
4	$ 1,914	$ 311	19%

The NAECA and Roll-up scenarios reduce industry NPV compared to the Shift scenario. This result occurs because we assume the higher-operating cost manufacturers accrue much of their profits from the sale of higher efficiency equipment. As the standard level increases, they earn lower profit margins on that equipment. The loss in profits can be offset by the combination of more sales and more expensive equipment.

The Shift scenario provides a much more favorable projection of high-efficiency equipment sales than do the NAECA and Roll-up scenarios. The Roll-up scenario, whereby a new standard does not increase the shipments of equipment that exceed the minimum efficiency level, is the worst case of the three. The slight differences in shipments between the Roll-up and the NAECA scenarios are enough to double the loss of industry value. Later, we will discuss which scenarios we believe will dominate at each Trial Standard Level.

Notice that there is little difference between INPV effects between TSLs 2, 3, and 4 under the NAECA and Roll-up scenarios. Since most shipments occur at 10 SEER and 12 SEER, there is little negative effect on higher-operating-cost firms in moving to an 11 SEER standard (TSL 1). The large impact occurs at 12 SEER (TSL 2), when the profit margin on 12 SEER is squeezed. Once that impact is felt, there is little incremental impact in moving to the higher standard levels for a given efficiency scenario. However, we believe that the Roll-up efficiency scenario becomes increasingly likely under TSL3 and TSL4 as explained further in Section 8.4.8.

Tables 8.17 through 8.18 present the results for the 14 year life assumption and the Reverse Engineering Relative Cost scenario, both applied to the NAECA Efficiency Mix scenario.

Table 8.17 Changes in Industry Net Present Value — Industry Relative Cost, 14 Year Life, NAECA Efficiency Mix

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,726	--	--
1	$ 1,701	$ (25)	-1%
2	$ 1,558	$ (168)	-10%
3	$ 1,555	$ (171)	-10%
4	$ 1,598	$ (128)	-7%

Table 8.18 Changes in Industry Net Present Value — Reverse Engineering Relative Cost, 18 Year Life, NAECA Efficiency Mix

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,539	--	--
1	$ 1,509	$ (30)	-2%
2	$ 1,380	$ (159)	-10%
3	$ 1,368	$ (171)	-11%
4	$ 1,370	$ (169)	-11%

The Reverse Engineering and 14-year Life scenarios have little impact on the percent change in INPV compared to the Industry Mean and 18-year Life assumptions, the results of which are presented in Table 8.14. This means that cost and lifetime considerations are relatively unimportant compared to the assumptions regarding efficiency mix. These two sets of scenarios are not considered further in the MIA.

8.4.5 Impacts on Return on Invested Capital (ROIC)

ROIC is a measure of the effectiveness of capital employed. ROIC is calculated as net income divided by net operating capital. Therefore, a rise in employed capital without a corresponding rise in net income will cause ROIC to drop. A low ROIC can prompt a company to deploy those assets in a more profitable business, or to liquidate them altogether. Unless a significant change in finances occurs, ROIC changes little from year to year. Therefore, we report only the ROIC in 2011, five years after a new standard would become effective.

Table 8.19 presents the 2011 ROIC results for the industry for each of the three efficiency scenarios using the 18 year lifetime and ARI Mean cost assumptions.

Table 8.19 Impacts on Industry's Return on Invested Capital in 2011

Trial Standard Level	NAECA		Roll-up		Shift	
	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base
Base	13.3%	--	13.3%	--	13.3%	--
1	12.6%	-5%	11.3%	-15%	14.1%	6%
2	10.9%	-18%	9.5%	-29%	14.0%	5%
3	10.8%	-19%	9.5%	-29%	14.1%	6%
4	10.5%	-21%	9.5%	-29%	13.9%	5%

As is the case with INPV results, there is little change in the ROIC results above TSL 2 within each scenario.

8.4.6 Impacts on Annual Cash Flow

While NPV and ROIC are most useful for evaluating the long-term effects of new standards, short-term changes in cash flow are also important indicators of the industry's financial situation. For example, a large investment over a period of one or two years could strain the industry's access to capital, or a sharp drop in performance could cause investors to flee, even though recovery may be near. Thus, a short-term disturbance can have long-term effects that the GRIM cannot capture. To get an idea of the volatility of annual net cash flows, we report the annual undiscounted cash flow series from 2000 through 2016.

Figures 8.3 through 8.5 present the annual net cash flows for the base case and each of the three efficiency scenarios using the 18 year lifetime and ARI Mean cost assumptions.

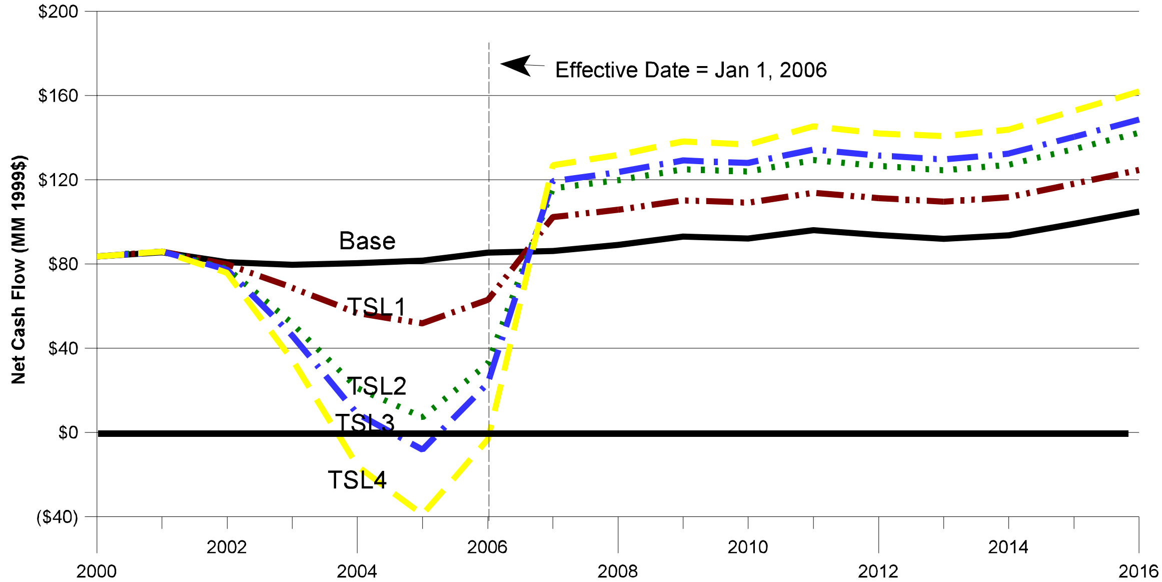

Figure 8.3 Industry Net Cash Flow -- Shift Efficiency Scenario

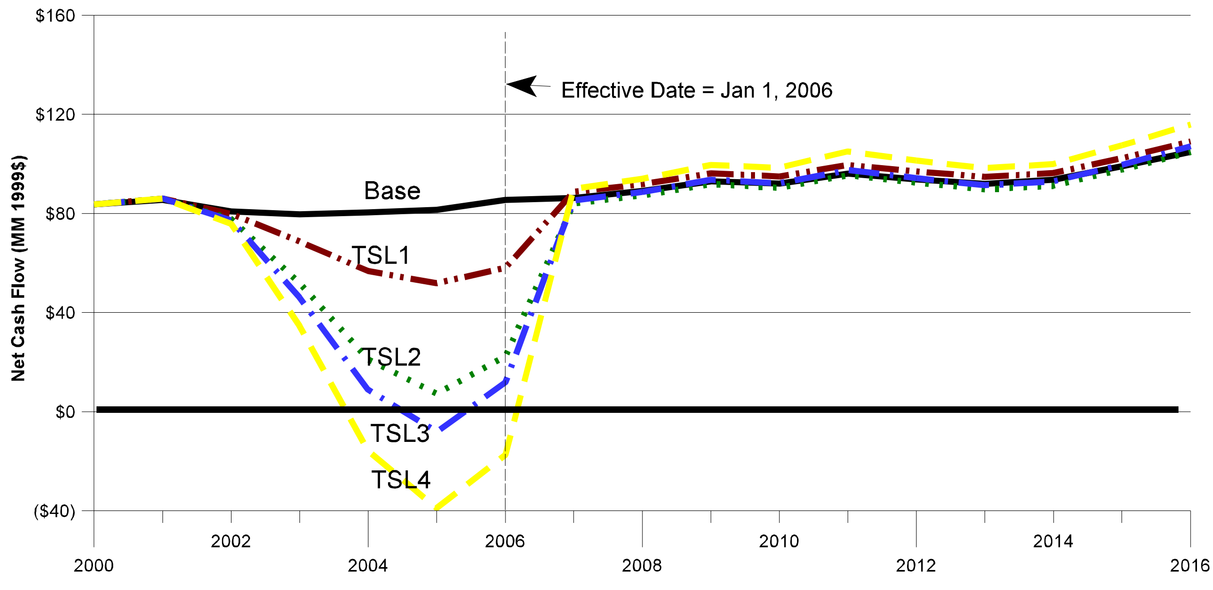

Figure 8.4 Industry Net Cash Flow -- NAECA Efficiency Scenario

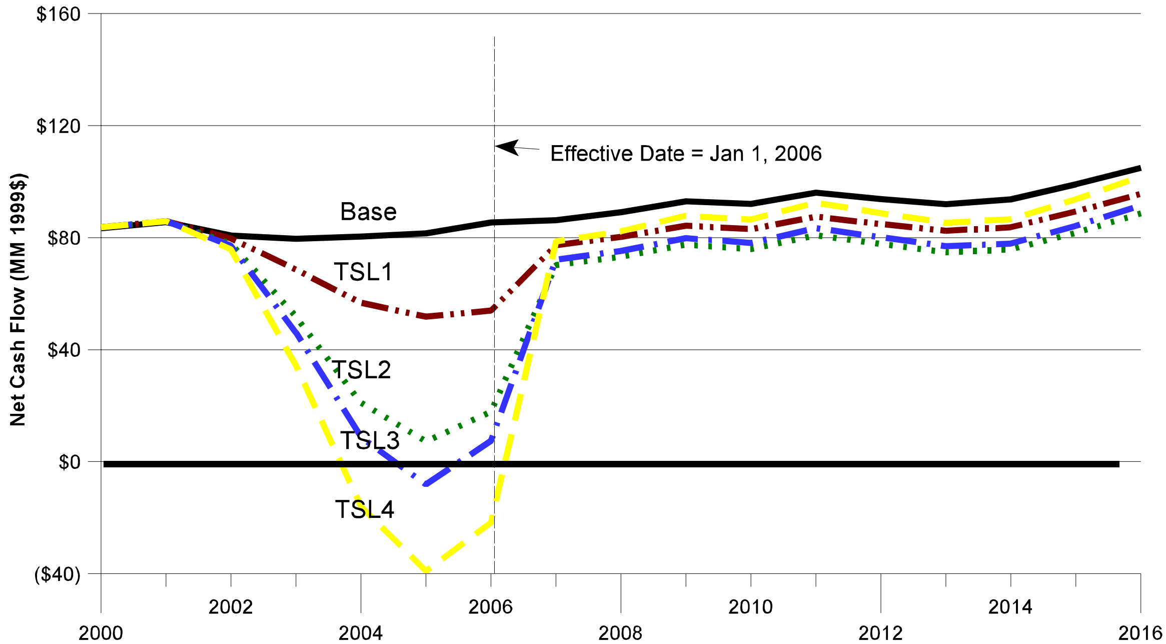

Figure 8.5 Industry Net Cash Flow -- Roll-up Efficiency Scenario

Prior to the effective date, the cash flows are nearly identical for all three scenarios. They are driven by the level of capital and product conversion investment assumed and factors which describe our assumptions of the proportion of those investments spent each year. In the year the standard becomes effective (2006) some residual product conversion expense occurs and there is a one-time dip due to the requirement for more working capital in that year.

The scenarios differ substantially in the years following the effective date. Compared to the base case, the Shift scenario net cash flow results are higher, the Roll-up scenario results are lower, and the NAECA scenario results are similar. Thus, under the NAECA scenario, the level of investment required explains most of the projected loss in INPV. Under the Roll-up scenario, INPV is negatively impacted by the unrecovered investment as well as the lower net cash flows that result from stagnant shipments of higher efficiency, premium equipment. Under the Shift scenario, manufacturers are more than able to recover their investments.

8.4.7 Impacts by Efficiency Level

The previous sections have illustrated the important role that the efficiency mix assumptions play in the financial projections. This section examines the other main factor, which is the contribution of products in each efficiency level to industry profits.

We have already described the dynamics by which the profits of manufacturers with higher operating costs depend on the sale of premium products, and how those products are differentiable only at efficiency levels higher than the baseline. In the GRIM, we model this effect as gross margins that increase linearly with efficiency level. Linearly increasing gross margins produce exponentially increasing profit margins (EBIT) that drive net cash flow. The relationship between efficiency level and profits is tempered somewhat by the presence of the lower-operating cost manufacturers. We assume that their gross margins and profit margins do not change as the efficiency level increases.

Figures 8.6 through 8.8 illustrate for each efficiency scenario how the industry's collective EBIT, as projected in 2011, depends on the sale of products at each efficiency level.

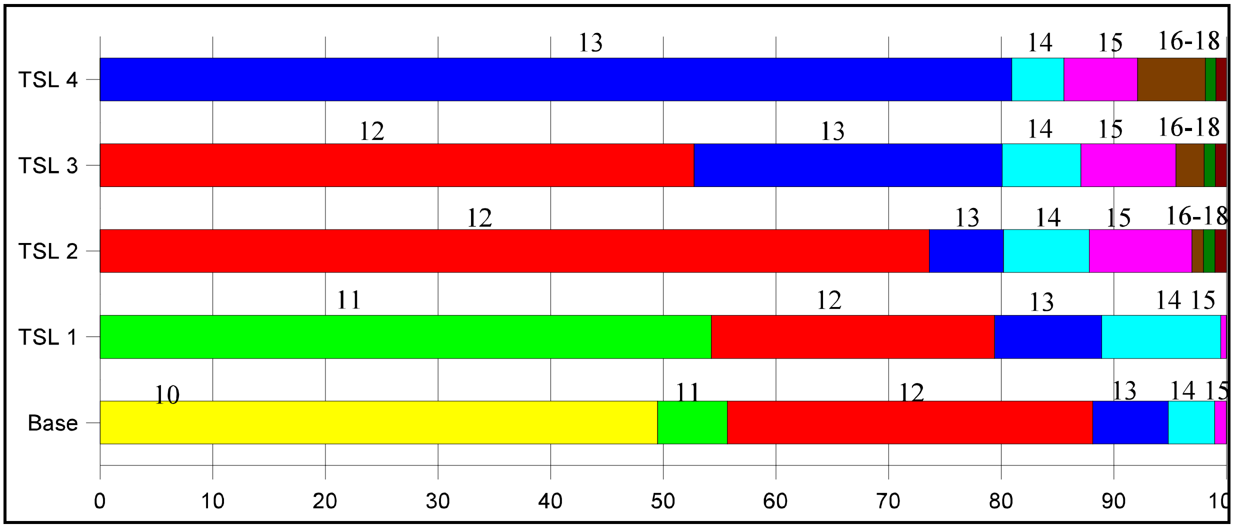

Figure 8.6 Contribution of Products at Each Efficiency Level to Industry Profits (EBIT) under Trial Standards – NAECA Efficiency Scenario

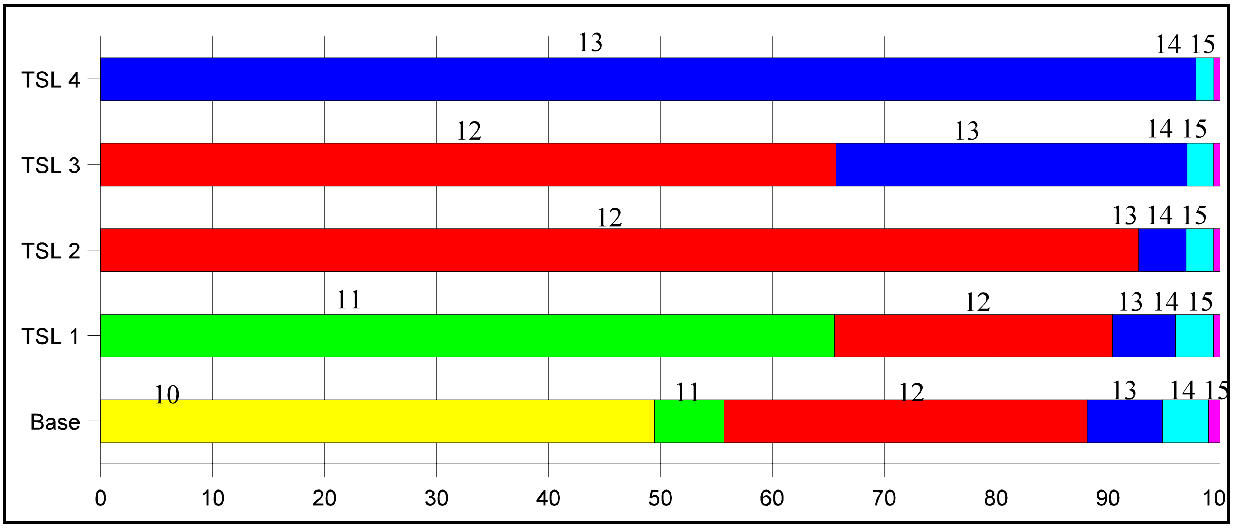

Figure 8.7 Contribution of Products at Each Efficiency Level to Industry Profits (EBIT) under Trial Standards – Roll-up Efficiency Scenario

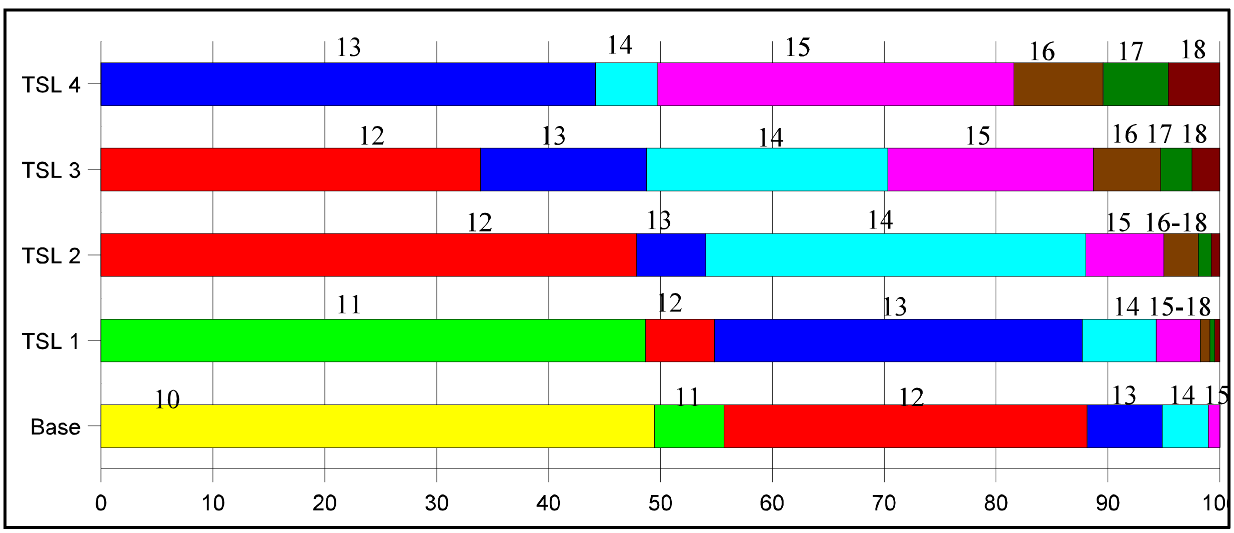

Figure 8.8 Contribution of Products at Each Efficiency Level to Industry Profits (EBIT) under Trial Standards – Shift Efficiency Scenario

The base case for all three scenarios is identical. Ten SEER products contribute only about 50 percent of the industry's EBIT, even though they comprise 76 percent of the units sold. Eleven and 12 SEER products contribute another 38 percent of EBIT. Since those levels comprise only 21 percent of units sold, this reveals the importance of the 12 SEER level to industry finances. Overall, the lowest three efficiency levels contribute 88 percent to EBIT, and the rest contribute12 percent.

As the efficiency scenarios project different shipments, they alter the relative contribution of each level of product to EBIT. For example, in the Roll-up scenario, the EBIT contribution of products at 14 SEER and above drops from 5 percent in the base case to 2 percent at TSL4. Meanwhile, the contribution of the minimum efficiency product grows from 50 percent in the base case (10 SEER) to 97 percent at TSL4 (13 SEER). This means that under the Roll-up scenario manufacturers are increasingly dependent on their baseline product to generate profits. Since the baseline air conditioner is a low margin, price sensitive product, the Roll-up scenario describes a transition to a commodity-driven industry.

The Shift scenario describes the opposite phenomenon. Here, manufacturers are able to sell seemingly as much high efficiency equipment as they desire. The EBIT contribution of baseline equipment stays fairly constant, and actually drops to around 45 percent under TSL4. At the same time, the EBIT contribution of equipment 14 SEER and above grows from 5 percent to 55 percent. The Shift scenario describes a transition to an efficiency-driven industry.

The NAECA scenario displays characteristics of both the Roll-up and Shift scenarios, but bears a closer resemblance to Roll-up. Still, the EBIT analysis magnifies the slight differences between the NAECA and Roll-up scenarios in units sold. Under the NAECA scenario, the EBIT contribution of the baseline products grow only to 81 percent under TSL4 (versus 97 percent under the Roll-up scenario) and the contribution of products 14 SEER and above grows to 19 percent under TSL4 (versus 3 percent under the Roll-up scenario).

8.4.8 Efficiency Scenario Assessment

Since the GRIM results are so strongly tied to the selection of efficiency scenario, it is important to consider the likelihood of any of the scenarios actually occurring, and what conditions would tend to promote one over another.

The closer the baseline unit is to the technological limit the fewer consumers will “buy up” to a higher efficiency. For more and more consumers, the baseline will be the cost-effective option, and those consumers who wish to “buy up” will have fewer options and less financial incentive to do so. We can examine this situation by examining the payback periods resulting from a consumer’s decision to “buy up” in efficiency. Today, for instance, a large fraction of consumers are willing to purchase 12 SEER equipment. According to the definition of SEER, this 2 SEER boost over the baseline 10 SEER results in a 16.7 percent decrease in energy consumption for the average user (1-10/12), who would assume that would translate into a 16.7 percent savings in annual operating costs. Thus, the theory is that, for whatever reason, some consumers are willing to pay the 12 SEER product’s premium in order to obtain the 16.7 percent savings in operating cost. Assuming a 10 SEER production cost of $893 and a 47.4 percent price premium of a 12 SEER over a 10 SEER (based on the Industry Mean relative production cost multipliers[1], a 25 percent/75 percent blend of lower/higher operating cost manufacturer markups presented in Table 8.7, and the distribution markups presented in Table D.1), and an annual operating cost of $250, that translates into a 10.1 year simple payback. (0.474*893/0.167*250 = 10.1). Table 8.20 provides the same calculations for the other SEER levels available.

Table 8.20 Consumer Payback for Efficiency Upgrades of Split Air Conditioners Under a 10 SEER Standard using Industry Mean Relative Costs and a "Flat" Markup

Efficiency (SEER)	Energy Savings versus 10 SEER	Price Premium versus 10 SEER	Simple Payback (years)
10	--	--	--
11	9%	21%	8.1
12	17%	47%	10.1
13	23%	82%	12.7
14	29%	136%	17.0
15	33%	185%	19.9

Table 8.21 provides the simple payback calculations for products under new standard levels assuming the same Industry Mean production cost multipliers.

[1] Relative production cost multipliers are intended to represent the costs of baseline equipment under new standards only. Using them as a proxy for estimating the cost of producing more efficient equipment under a lower standard level yields only approximate results. On one hand, the method underestimates those costs by including production efficiencies gained under high volume baseline production. On the other hand, it tends to overestimate those costs by including amortized conversion costs. The subtlety has little effect on the results of the GRIM analysis.

Table 8.21 Consumer Payback (years) for Efficiency Upgrades of Split Air Conditioners Under a New Standard Levels using Industry Mean Relative Costs

Equipment Efficiency (SEER)	Standard Level (SEER)				
	10	11	12	13	14
10	--	--	--	--	--
11	8.1	--	--	--	--
12	10.1	11.6	--	--	--
13	12.7	15.0	17.7	--	--
14	17.0	19.7	23.9	28.7	--
15	19.9	23.3	26.9	31.1	31.0

Payback periods for each additional SEER are longer at higher standard levels. This suggests that under new standard levels, consumers will have less of a financial incentive to "buy up" compared to consumers today.

Table 8.22 shows that the picture is similar using Reverse-Engineering-based relative production costs. In that case, the payback to buy up 2 SEER points from 10 SEER is 8.1 years, which again is not possible to find under standard levels higher than 10 SEER.

Table 8.22 Consumer Payback (years) for Efficiency Upgrades of Split Air Conditioners Under a New Standard Levels using Reverse Engineering Costs

Equipment Efficiency (SEER)	Standard Level (SEER)				
	10	11	12	13	14
10	--	--	--	--	--
11	6.4	--	--	--	--
12	8.1	9.1	--	--	--
13	9.4	10.9	12.0	--	--
14	13.8	16.1	19.7	26.4	--
15	17.2	20.4	24.0	29.9	31.2

If we assume that consumers under new standards will "buy up" in the same proportion as they do today (the Shift scenario) only if they are able to achieve the same paybacks, it is clear that new standards, by resulting in longer payback periods, reduce the possibility of the Shift scenario occurring.

Of course, it would be possible to achieve those shorter payback periods if the price differential between baseline products and higher efficiency products were to decrease under new standards. For example, if under a 12 SEER standard the price of a 14 SEER product dropped 20 percent and the price of a 12 SEER product dropped 10 percent, more consumers would be willing to purchase the 14 SEER product because of the shorter payback period. If the differential price dropped low enough, the payback period between a 12 SEER and 14 SEER would equal today's payback period between a 10 SEER and 12 SEER product, and we could imagine that the same number of consumers would buy-up to 14 SEER as do today to 12 SEER, bringing about the Shift scenario. Table 8.23 shows the reduction in differential prices that would have to occur in order to reproduce the simple paybacks offered under the current 10 SEER standard.

Table 8.23 Required Decrease in Split Air Conditioner Price Differentials Under New Standard Levels to Reproduce the Consumer Paybacks Realized under the 10 SEER Standard Level – Industry Mean Relative Production Costs

Equipment Efficiency (SEER)	Standard Level (SEER)				
	10	11	12	13	14
10	--	--	--	--	--
11	--	--	--	--	--
12	--	-30%	--	--	--
13	--	-32%	-54%	--	--
14	--	-36%	-58%	-72%	--
15	--	-27%	-53%	-67%	-74%

Table 8.23 shows, for example, that under a 12 SEER standard, the price differential between a 12 SEER unit and a 14 SEER unit would have to drop by 58 percent from our estimates in order to offer the 10.1 year payback that consumers currently realize in a product that exceeds the current baseline by 2 SEER. The required reductions are lower under an 11 SEER standard (27 to 36 percent) and higher under a 13 SEER standard (67 to 72 percent).

Table 8.24 provides results of the same calculations using Reverse-Engineering relative costs, which require comparable decreases in price differentials.

Table 8.24 Required Decrease in Split Air Conditioner Price Differentials Under New Standard Levels to Reproduce the Consumer Paybacks Realized under the 10 SEER Standard Level – Reverse Engineering Mean Relative Production Costs

Equipment Efficiency (SEER)	Standard Level (SEER)				
	10	11	12	13	14
10	--	--	--	--	--
11	--	--	--	--	--
12	--	-30%	--	--	--
13	--	-26%	-46%	--	--
14	--	-41%	-59%	-76%	--
15	--	-32%	-61%	-73%	-79%

It is highly unlikely that these reductions in differential prices could be realized in the foreseeable future utilizing conventional technologies. Pricing pressure on baseline equipment would be downward under new standards, tending to increase, not decrease, the differential. Furthermore, any technological improvement that could reduce the price of higher efficiency equipment would also be adopted in baseline equipment, tending to keep the differential constant. Manufacturers could lower their markups on higher efficiency equipment to stimulate shipments, but that action could reduce rather than increase total profits.

Emerging technologies do have the potential to reduce the price differentials (see Section 4.5). Table 8.25 shows the maximum reduction in production cost differentials we would expect if the emerging technology with the greatest potential impact, advanced modulating compressors, were applied in split air conditioners with fancoils, using Reverse Engineering relative cost multipliers. To the extent that cost reductions are passed on to consumers, the reduction in price differentials would be similar.

Table 8.25 Maximum Decrease in Split Air Conditioner (fancoil) Production Cost Differentials Under New Standard Levels using Emerging Technologies

Equipment Efficiency (SEER)	Standard Level (SEER)				
	10	11	12	13	14
10	--	--	--	--	--
11	0%	--	--	--	--
12	0%	0%	--	--	--
13	-49%	-58%	-82%	--	--
14	-45%	-50%	-65%	-27%	--
15	-47%	-52%	-65%	-42%	-65%

Note that the reductions in Table 8.25 exceed those shown in Table 8.24, indicating that it may be possible to duplicate today's consumer "buy up" payback periods for some products using emerging technologies, thereby bringing about the Shift scenario for those products. The viability of emerging technologies is far from certain, but more stringent efficiency regulations clearly provide incentive for manufacturers to develop and deploy them in an attempt to induce the Shift scenario.

If, on the other hand, price differentials change according to an analysis based strictly on conventional technologies, we would expect an outcome even more severe than the Roll-up scenario. For example, in Table 8.22, the payback to move from a 10 SEER unit to a 13 SEER unit today is 9.4 years. Under a 12 SEER standard, however, the payback to move to a 13 SEER is 12 years. That suggests that fewer consumers would purchase a 13 SEER unit under a 12 SEER standard than do today under a 10 SEER standard. This "collapse" scenario is more pessimistic than the Roll-up scenario which predicts that purchases of 13 SEER equipment would stay the same. Of course, manufacturers, dealers, utilities, and government programs would attempt to maintain demand for higher efficiency equipment, but a collapse scenario is certainly possible, particularly at the highest standard levels where the payback periods become significantly longer.

Since the NAECA scenario is the only scenario based on historical observation, it is certainly reasonable to consider it the one most likely to occur under increases in the standard level of a similar magnitude as NAECA imposed (TSL1/TSL2). There are differences, however, between the market today and that of 1987 when the NAECA standards were announced. At that time, 8 and 9 SEER products were being sold in fairly similar proportion (40 percent each), although 9 SEER products were taking share rapidly from 8 SEER. Products over 10 SEER, which itself made up 15 percent of sales, were also gaining share. Thus, the unregulated market was in the midst of a transition toward higher efficiency that had been underway for at least a decade. This transition was influenced by a burst of activity in technological development that allowed air conditioner efficiency to increase with little change in production cost. Specifically, advances in compressor efficiency and fin and coil design were underway. Sales volumes were increasing, companies were consolidating, and new design and production technologies allowed manufacturers to reduce operating expenses, product development cycle times, and production costs.

Since 1992, these technological advances have proceeded at a much slower pace. Compressor efficiency has seen little improvement, and no new heat exchanger technologies have been introduced in several years. Since the baseline 10 SEER product and the popular 12 SEER product are approaching the practical limit on coil-only residential equipment efficiency of 14.5 SEER, the cost of realizing further compressor and heat exchanger efficiency improvements is much higher, and the potential financial return is much lower. In other words, today's market faces a "cap" that was in the process of being raised rapidly when NAECA went into effect.

Thus, the "buy up" payback analysis would suggest that the NAECA scenario represents a likely outcome only under an 11 SEER standard level. Under a 12 SEER standard, the Roll-up scenario would be more likely to occur than the NAECA scenario. Under a 13 SEER standard, the Roll-up scenario would actually be optimistic. Should emerging technologies reach their full potential, however, the paybacks seen today in moving to higher efficiency products could be attained, suggesting that the Shift scenario may be possible for some products under any standard level.

The preceding analysis based on paybacks does not consider that consumers who "buy up" may be attracted to absolute annual savings rather than payback periods. As standard levels increase, even if price differential decrease to maintain payback periods, annual savings decrease in absolute terms. Under this framework, it is difficult to imagine conditions under which the Shift scenario could occur, even with emerging technologies reaching their full potential.

8.5 SUBGROUP IMPACTS

The results in Section 8.4 relate to the residential air conditioning manufacturing industry as a whole. There are segments of the industry that an observer would suspect could be more negatively or positively impacted than the typical firm. In section 8.4.3 we discussed that differences exist between major manufacturers based on their market approach and cost structure. It is also reasonable to assume that low volume manufacturers, most of whom rely on the sale of niche products, would experience impacts that differ from the major manufacturers. Furthermore, producers of specialized components may also be impacted more or less severely than the major OEMs.

The Department is interested in the impacts on each of these segments for different reasons. First, understanding the differences between low- and high-operating cost manufacturers can help to identify companies that are likely to consolidate or change their R&D strategy. The Department would not want to impose a standard that removed the incentive for the private sector to continue its innovation. Second, the law requires the Department to evaluate impacts of new standards on small businesses. Many small businesses in the air conditioning industry manufacture niche products, and in some cases, the Department may be obliged to modify the standards to protect those companies from impacts that would eliminate those products from the marketplace. Third, if the standard favored a particular component supplier, it could alter competition in that area and result in higher prices to the OEM and eventually the consumer. The Department of Energy and the Department of Justice are both interested in examining possible influences of new standards on the competitive balances in the industry.

8.5.1 Major Manufacturer Subgroups -- Lower Operating Cost and Higher Operating Cost

Section 8.4.3 introduced the concept of segmenting the industry into two major groups based on their operating cost structure and approach to market. Those with lower operating cost target price sensitive markets and limit their R&D efforts, service programs, and frills. They depend on their baseline equipment to generate most of their profits, and will generally benefit from more stringent efficiency standards. The manufacturers with higher operating costs place more emphasis on product development and research, service programs, and other value-added attributes. Premium products and higher efficiency products generate a substantial portion of their profits. More stringent efficiency standards tend to reduce the profitability of those products. This section describes some of the differences in GRIM assumptions and results for the two groups.

8.5.1.1 Differences in Assumptions between the Subgroups

We developed this characterization of the two groups over the course of two years and more than a dozen interviews with major manufacturers. Each company described its own unique situation and concerns, but some similarities began to emerge that suggested the classification we developed. Although manufacturers may not think of themselves as falling into one of two groups, the simplification was necessary to capture what we believe to be the main differences among companies with regard to the impacts of new efficiency standards on their businesses. We found that the framework helps us assess not only financial impacts, but partially explains why companies react differently to the prospect of increased standards.

In the GRIM, the primary difference between the two groups is their markup structure as presented in Table 8.7. The lower operating cost group maintains a fixed gross margin across efficiency levels, and the higher operating cost group increases their gross margin linearly as efficiency increases. This increasing margin represents either increasing margins within a product line, or a growing fraction of sales of premium, high margin, products.

We also made some minor adjustments to operating expense ratios to simulate somewhat the differences between the two groups of manufacturers. While these differences do not have much of an effect on the results, they are useful for distinguishing the two groups and calibrating the markups and profit margins. Table 8.26 summarizes the different operating cost assumptions.

Table 8.26 Operating Cost Assumptions for the Two Major Manufacturer Subgroups

	Lower Operating Cost Group	Higher Operating Cost Group
R&D Expense (% of revenues)	1.0%	2.0%
SG&A Expense (% of revenues)	14.0%	18.0%

The operating expense differences, in addition to the differences in markups, produce differences in price and profit margins between the two groups. Table 8.27 summarizes GRIM's prices under a 10 SEER standard level based on the Industry Mean relative production costs (see footnote 1 on page 8-35). Product premiums range from $19 (4%) for 10 SEER split air conditioners to $625 (41%) for 15 SEER packaged heat pumps.

Table 8.27 Equipment Price Assumptions for Lower Operating Cost (LOC) and Higher Operating Cost (HOC) Subgroups Under a 10 SEER Standard

Equipment Efficiency (SEER)	SAC-LOC	SAC-HOC	PAC-LOC	PAC-HOC	SHP-LOC	SHP-HOC	PHP-LOC	PHP-HOC
10	$483	$502	$583	$605	$681	$707	$689	$715
11	$555	$609	$652	$741	$732	$811	$700	$845
12	$636	$744	$677	$837	$804	$951	$686	$929
13	$750	$932	$829	$1,094	$916	$1,153	$871	$1,260
14	$944	$1,222	$969	$1,325	$1,052	$1,383	$1,023	$1,514
15	$1,123	$1,521	$1,179	$1,669	$1,359	$1,858	$1,202	$1,827

SAC- Split Air Conditioner; PAC-Packaged Air Conditioner; SHP-Split Heat Pump; PHP-Packaged Heat Pump

Table 8.28 summarizes the differences in profitability (EBIT) for each manufacturer group at each efficiency level according to the GRIM in the year 2000.

Table 8.28 Profit (EBIT) per Unit Sold (2000)

Equipment Efficiency (SEER)	Higher Operating Cost Group	Lower Operating Cost Group
10	4%	6%
11	7%	6%
12	11%	6%
13	14%	6%
14	17%	6%
15	20%	6%

To calculate EBIT by efficiency level, we assumed that corporate operating costs are allocated to each efficiency level in proportion to the revenues generated at that level. In actuality, firms have the flexibility to allocate overhead and operating costs however they choose to create different metrics and incentives for management. For example, some firms may prefer to allocate overhead based on labor cost, instead of revenue. This would produce different EBIT results.

We made sure to calibrate the assumptions regarding operating expenses and markups so that both groups displayed similar overall profit margins that were in line with the industry as a whole. The GRIM's before-tax EBIT for the lower operating cost group is 6.04 percent versus 6.09 percent for the higher operating cost group. Keeping profitability roughly equal between the two groups helps to reduce fluctuations in the combined INPV when the results of the two groups are added together, allowing us to focus on differences in profitability due only to the impact of new standards.

In summary, the parameters that we adjusted were:

- R&D expense ratio
- SG&A expense ratio
- Markups

We tried to maintain an EBIT of 6 percent while keeping the parameters within bounds that we developed during the course of our interviews and our evaluation of pubic financial data.

8.5.1.2 Net Present Value Impacts

Section 8.4.4 presented the results of the GRIM analysis of INPV impacts on the entire air conditioner manufacturing industry assuming that higher operating cost manufacturers comprise 75 percent of the market and lower operating cost manufacturers comprise 25 percent. This section explores the INPV results for each subgroup.

8.5.1.2.1 Lower Operating Cost Subgroup NPV Results

Tables 8.29 through 8.31 present the results of the GRIM analysis of INPV impacts on lower operating cost manufacturers. All results assume ARI mean relative costs and 18 year equipment life.

Table 8.29 Changes in Net Present Value – Lower Operating Cost Subgroup – NAECA Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case $ million	Change in NPV from Base Case %
Base	$ 375	--	--
1	$ 394	$ 19	5%
2	$ 401	$ 26	7%
3	$ 407	$ 32	9%
4	$ 430	$ 55	15%

Table 8.30 Changes in Net Present Value – Lower Operating Cost Subgroup – Roll-up Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case $ million	Change in NPV from Base Case %
Base	$ 375	--	--
1	$ 387	$ 12	3%
2	$ 392	$ 17	5%
3	$ 398	$ 23	6%
4	$ 422	$ 47	13%

Table 8.31 Changes in Net Present Value – Lower Operating Cost Subgroup – Shift Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 375	--	--
1	$ 403	$ 28	7%
2	$ 421	$ 46	12%
3	$ 429	$ 54	14%
4	$ 453	$ 78	21%

Lower operating cost manufacturers are expected to benefit slightly from any increase in the efficiency standard under any efficiency scenario. Production costs are increasing at a faster rate than sales volumes are dropping, so revenues increase. The fixed gross margins generate enough cash flow to fully recover the required investments, with excess to contribute to an increase in NPV.

8.5.1.2.2 Higher Operating Cost Subgroup NPV Results

Tables 8.32 through 8.34 present the results of the GRIM analysis of INPV impacts on higher operating cost manufacturers.

Table 8.32 Changes in Net Present Value – Higher Operating Cost Subgroup – NAECA Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,228	--	--
1	$ 1,172	$ (56)	-5%
2	$ 1,016	$ (212)	-17%
3	$ 999	$ (229)	-19%
4	$ 990	$ (238)	-19%

Table 8.33 Changes in Net Present Value – Higher Operating Cost Subgroup – Roll-up Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,228	--	--
1	$ 1,034	$ (194)	-16%
2	$ 849	$ (379)	-31%
3	$ 838	$ (390)	-32%
4	$ 846	$ (382)	-31%

Table 8.34 Changes in Net Present Value – Higher Operating Cost Subgroup – Shift Efficiency Scenario

Trial Standard Level	Net Present Value ($ million)	Change in NPV from Base Case	
		$ million	%
Base	$ 1,228	--	--
1	$ 1,337	$ 109	9%
2	$ 1,404	$ 176	14%
3	$ 1,425	$ 197	16%
4	$ 1,461	$ 233	19%

Higher operating cost manufacturers display a benefit only under the Shift scenario, which we have indicated is a highly unlikely outcome of new standards. Under the NAECA and Roll-up scenarios, which are more probable, this subgroup loses a considerable amount of value. Although revenues rise under new standards, margins and profits decline. This effect prevents the subgroup from recovering its investments related to the new standard, reducing the NPV. Under TSL3, for example, the NPV loss per company would be on the order of $40 million.

8.5.1.3 Impacts on Return on Invested Capital (ROIC)

As explained in section 8.4.5, ROIC measures the effectiveness of the industry's capital investment. Since new efficiency standards would cause manufacturers to make investments that would not result in an increase in profits, ROIC drops for the industry as a whole. However, the lower operating cost subgroup would experience little change in ROIC. The ROIC change in the higher operating cost subgroup drives the industry ROIC results.

Tables 8.35 through 8.36 provide the ROIC results for the two subgroups under each efficiency scenario.

Table 8.35 Changes in ROIC in 2011 – Lower Operating Cost Subgroup

Trial Standard Level	NAECA		Roll-up		Shift	
	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base
Base	13.2%	--	13.2%	--	13.2%	--
1	13.6%	3%	13.4%	2%	13.9%	5%
2	13.2%	0%	13.0%	-2%	13.8%	5%
3	13.3%	1%	13.0%	-2%	13.9%	5%
4	13.5%	2%	13.3%	1%	14.0%	6%

Table 8.36 Changes in ROIC in 2011 – Higher Operating Cost Subgroup

Trial Standard Level	NAECA		Roll-up		Shift	
	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base	Return on Invested Capital (ROIC)	Change in ROIC from Base
Base	13.3%	--	13.3%	--	13.3%	--
1	12.3%	-8%	10.7%	-20%	14.2%	7%
2	10.2%	-23%	8.4%	-37%	14.2%	7%
3	10.0%	-25%	8.3%	-38%	14.2%	7%
4	9.6%	-28%	8.3%	-38%	14.0%	5%

The decrease in ROIC in the higher operating cost subgroup under both the NAECA and Roll-up scenarios is of concern since we expect those to be the most likely outcomes at TSL2 and TSL3, respectively. The results suggest that higher operating cost firms would strive to reduce their capital expenditures below that assumed for the GRIM and to tailor their conversion in such a way that their expenditures allow them to meet the efficiency standard but also improve productivity, reduce costs, or otherwise improve profitability. More drastic reactions are possible. Capital currently dedicated to the production of air conditioners could be diverted to more profitable uses. This can be accomplished through liquidation or conversion of the assets to the production of different types of products. However, conversion to new products has associated costs of its own, and it is likely that companies would choose to invest in meeting the new standard rather than to pursue such a path. More likely, some companies may decide to sell their air conditioning assets to other companies who would continue to use them in the production of air conditioners. This sort of divestiture would improve the selling company's ROIC (by turning capital into cash that can then be redeployed), and the purchasing company would secure a price for those assets that allowed it to meet its ROIC targets. During our interviews, manufacturers commented that continued mergers within the industry certainly were probable.

8.5.1.4 Impacts on Annual Cash Flow

Section 8.4.6 discussed GRIM's results for industry net cash flow through 2016. Just as with INPV and ROIC, there are large differences in net cash flow results between the higher operating cost and lower operating cost subgroups. Again, the higher operating cost manufacturers would fare worse under new standards than would lower operating cost manufacturers.

8.5.1.4.1 Lower Operating Cost Subgroup Cash Flow Results

Figures 8.9 thorough 8.11 illustrate the net cash flow results for the lower operating cost subgroup under each Trial Standard Level for each efficiency scenario. Two characteristics stand out. First, cash flows in the years prior to the effective date of the standard dip due to expenditures related to product and capital conversion. For TSL3 and TSL4, cash flow can become negative, requiring the firm to draw from its cash reserves, liquidate investments, or borrow to fund operations. GRIM does not capture the opportunity costs associated with these financing activities. Cash flow results prior to the standard effective date are independent of the efficiency scenario since all investments occur prior to the effective date. Second, in the years following the effective date, cash flows recover and exceed the base case under all shipment scenarios for low operating costs manufacturers. The decline in shipments under new standards does not offset equipment cost increases which we assume low operating cost manufacturers pass through as price increases. This increase in revenues combined with fixed gross margins more than offsets expenditures related to new capital and results in stronger cash flows.

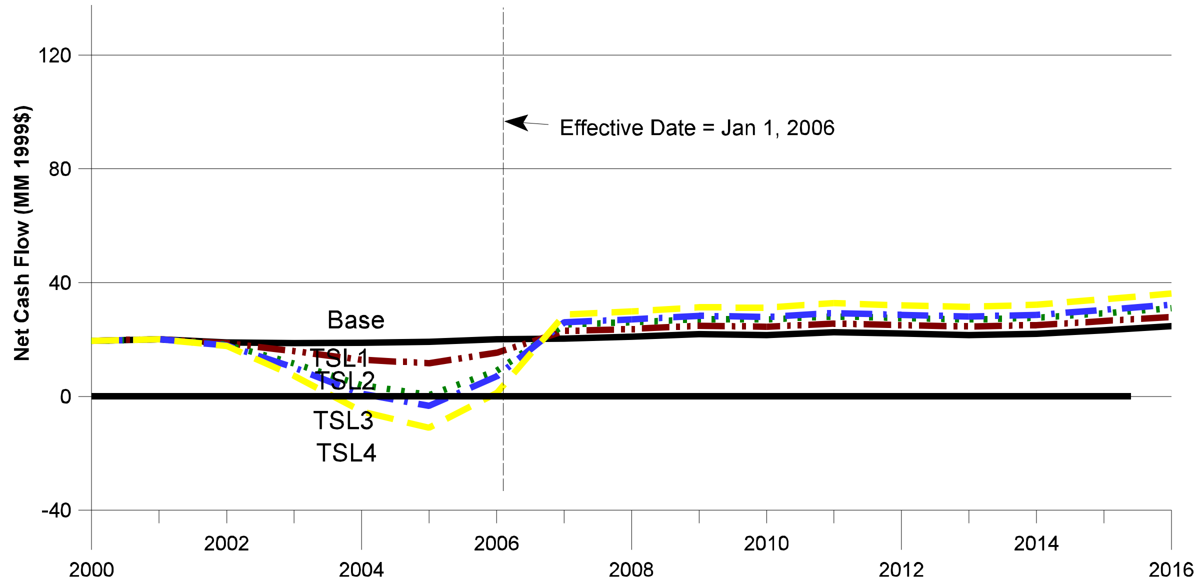

Figure 8.9 Net Cash Flows for the Lower Operating Cost Subgroup – NAECA Efficiency Scenario

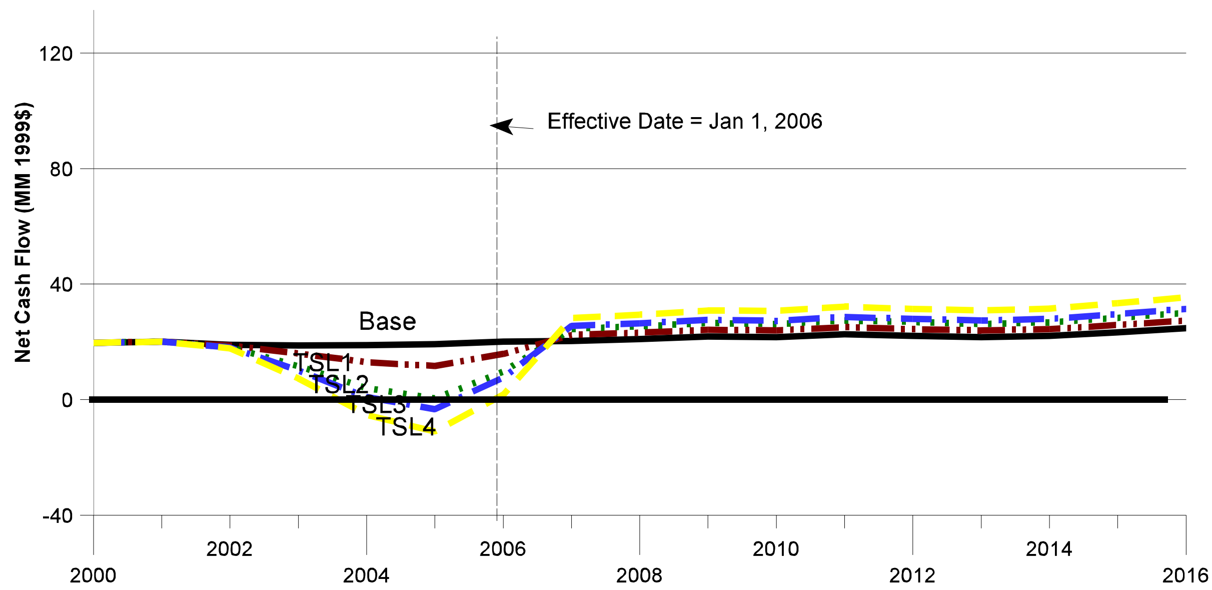

Figure 8.10 Net Cash Flows for the Lower Operating Cost Subgroup – Roll-up Efficiency Scenario

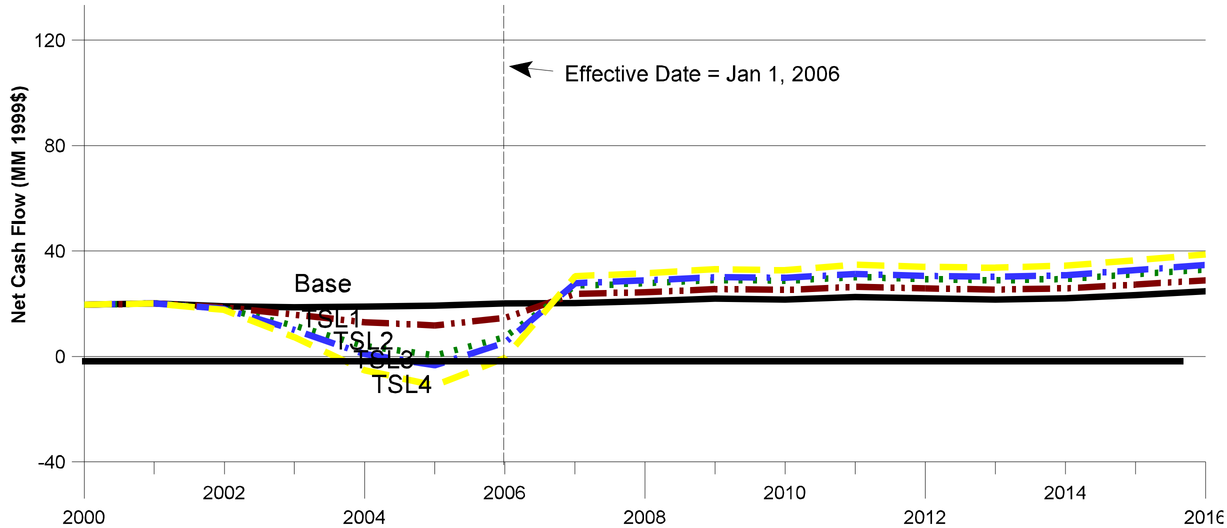

Figure 8.11 Net Cash Flows for the Lower Operating Cost Subgroup – Shift Efficiency Scenario

8.5.1.4.2 Higher Operating Cost Manufacturer Cash Flow Results

Net cash flow projections for higher operating cost manufacturers are shown in Figures 8.12 through 8.14. The explanation of the cash flow estimates is similar to that of the lower operating cost subgroup. Prior to the effective date, cash flow results are worse than for the base case due to expenditures related to the new standards. They become negative for TSL3 and TSL4. In fact, cash flows prior to the effective date are almost identical to those of the lower operating cost group, but three times higher by virtue of the 3-to-1 market share ratio we assumed. We allocated capital and product conversion costs according to the same 75 percent/25 percent ratio as we did sales volume. After the effective date, the cash flows of the higher operating cost group differ substantially from those of the lower operating cost group. Under the NAECA and Roll-up scenarios, cash flows for the higher operating cost group never attain the level of those in the base case. Pricing pressure requires higher operating cost manufacturers to absorb some of the cost increases related to more efficient equipment. Therefore, their stronger revenues are coupled with lower gross margins, resulting in lower cash flows than in the base case.

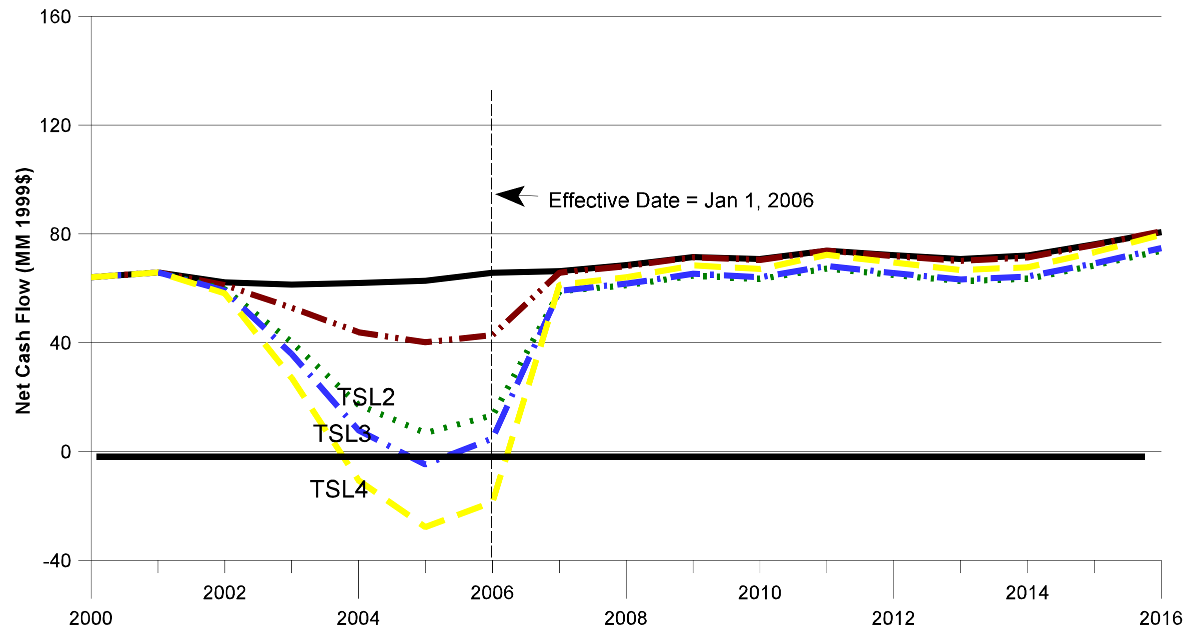

Figure 8.12 Net Cash Flows for the Higher Operating Cost Subgroup – NAECA Efficiency Scenario

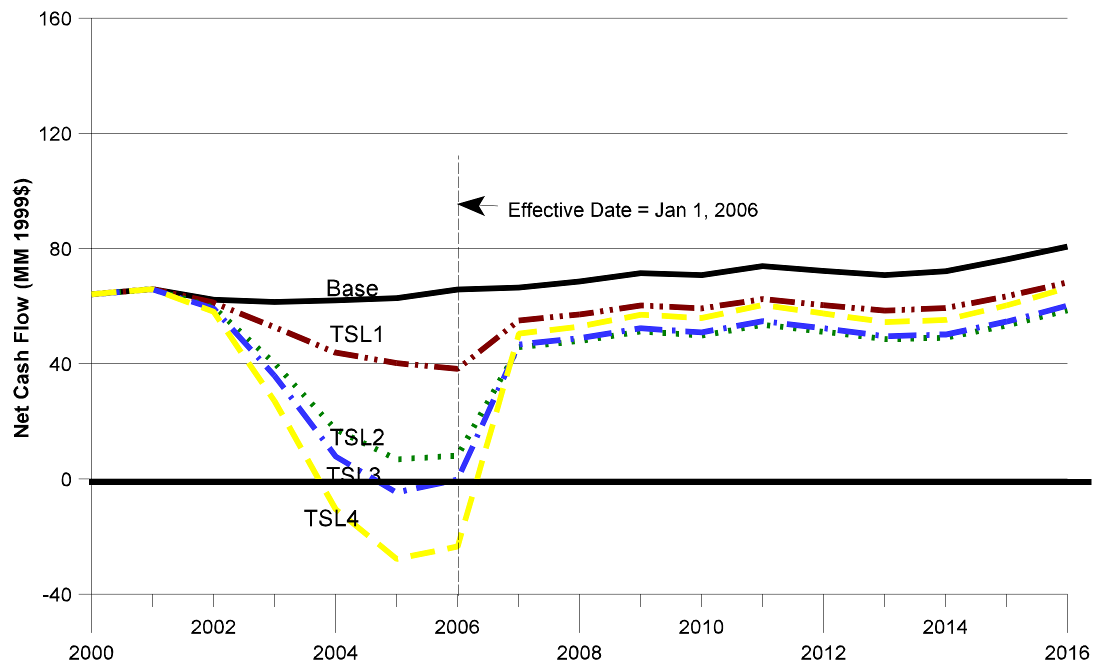

Figure 8.13 Net Cash Flows for the Higher Operating Cost Subgroup – Roll-up Efficiency Scenario

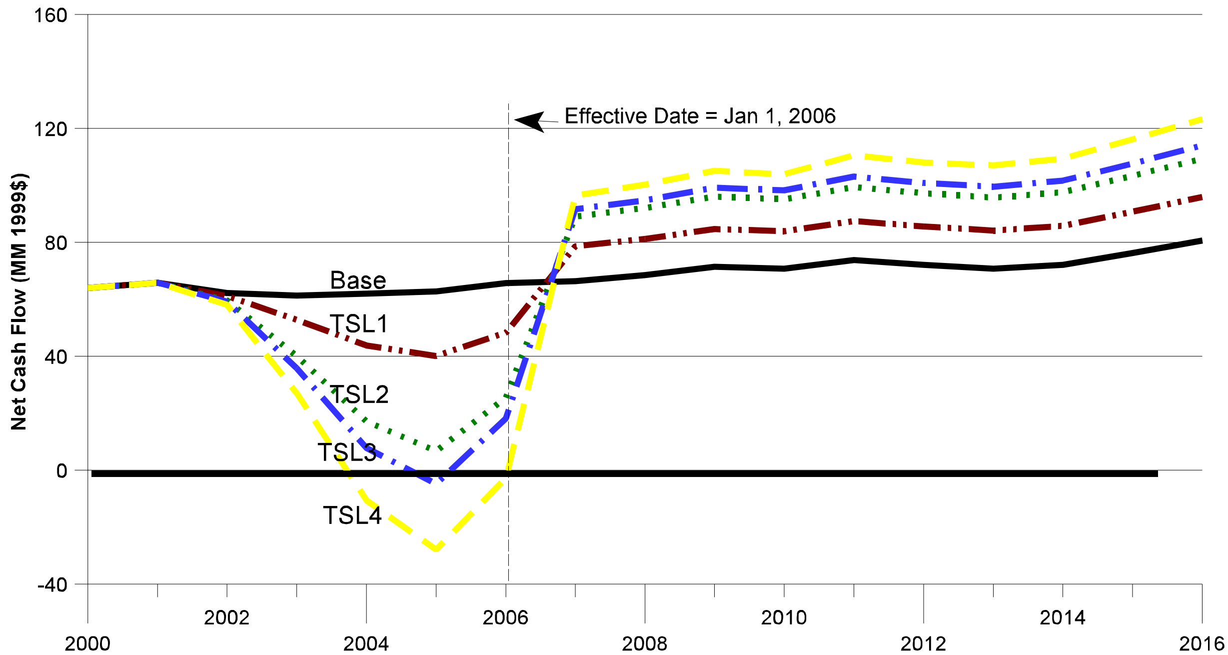

Figure 8.14 Net Cash Flows for the Lower Operating Cost Subgroup – Shift Efficiency Scenario

8.5.1.5 Summary of Impacts on Major Manufacturer Subgroups

GRIM analysis indicates that new efficiency standards will benefit manufacturers who have a low cost, commodity-product strategy. Owing to their lower operating costs, they are better positioned to pass their cost increases on to their customers in their baseline equipment. Conversely, the analysis indicates new standards, by reducing opportunities for product differentiation, will negatively impact higher operating cost, higher value-added, manufacturers who must absorb some cost increases in order for their baseline equipment to compete successfully on price with their lower cost competitors. Both groups could experience negative cash flows in the years leading up to the new standard under TSL3 and TSL4, but only the higher operating cost group is expected to suffer a long term decline in value, cash flow, and return on invested capital. The severity of these negative impacts depends to a large extent on which efficiency scenario occurs. The NAECA scenario is more likely to occur under TSL1, but the Roll-up scenario is more likely to occur under TSL2 and might underestimate impacts under TSL3 and TSL4. Therefore, based on the GRIM, we conclude that trial standard levels TSL2, TSL3, and TSL4 will impact higher operating cost manufacturers significantly and disproportionally.

In response, some companies in the higher operating cost subgroup may seek merger partners, and most will likely seek to reduce their production and operating expenses. Reductions in sales, service, and research expenditures would dampen innovation in the air conditioner industry. However, some companies may decide to redouble their efforts to develop and sell higher efficiency products, attempting to create the profitable Shift scenario for themselves. Their success would depend on their ability to develop a new generation of highly efficient equipment that is profitable at a far lower price premium than today's equipment. The prospect for such a development depends on the success of emerging technologies and their ability to decrease the price differential between efficiency levels.

8.5.2 Niche Product Manufacturer Subgroup

Since low volume manufacturers have fewer units over which to recover the costs associated with converting to new standards, we would expect the business impacts on low volume manufacturers to be more severe than those on major manufacturers. Indeed, the number of small manufacturers has declined over the last decade, and some manufacturers attribute that decline directly to the effects of the NAECA standards. Cost allocation is not the only issue. Low volume manufacturers typically possess less ample research and product development resources than their major competitors, and are not able to react as quickly or successfully to new standards.

Low volume manufacturers fall into two groups. The first is manufacturers of equipment for niche markets. Their products fill specific space conditioning needs that are not widespread enough to support the high sales volumes and economies of scale sought by the major manufacturers. The second group manufactures indoor coils and fancoil units.

Of the two groups, the indoor coil manufacturers bear the lowest burden. Indoor coil manufacturers must rate their coils with new outdoor units from other manufacturers, and may have to develop new coil configurations, but those expenses are minor in comparison to the expenses required to develop new product lines of matched systems. If new standards increase the size of the indoor coils, indoor coil manufacturers may bear some expense in increasing their production capacity and warehouses to accommodate them. However, indoor coil manufacturers we interviewed expressed no major concerns over the impacts of new standards on their businesses.

The niche product manufacturers, on the other hand, do raise some serious concerns. Those manufacturers whose products face tight constraints, usually on size, must overcome technical challenges in developing products to meet more stringent standards. Their ability to do so is limited by their engineering resources and the availability of useable components. If components do become available, they often do so at a much higher cost for low volume manufacturers compared to the major manufacturers. Assuming niche product manufacturers can meet their technical challenges, the costs of redesigning and retooling to produce those new products must be allocated over a relatively small number of unit sales. Compounding the problem, some niche manufacturers produce several types of niche products, all of which must be redesigned and re-certified. This higher allocation of costs, combined with the higher cost of components, raise the cost of niche products more than that of mainstream products from major manufacturers. Thus, we could expect a high drop in shipments and more downward pressure on gross margins. Both results impose a burden on niche product manufacturers that is disproportionately higher than that imposed on major manufacturers. These burdens would likely cause one or more companies to exit the market and could certainly cause the sale of several niche products to be discontinued.

Because each niche manufacturer's financial structure and product offering is unique, we did not perform a GRIM analysis on the niche manufacturer subgroup. Our assessment is qualitative based on interviews with five niche product manufacturers and information submitted to the Department in the form of public comment.

8.5.3 Compressor Supplier Subgroup

Although the manufacturers of systems and equipment are the primary focus of the MIA, new standards could also impact the price or availability of key components. The concern relates to components from a limited set of suppliers for which there are no viable substitutes and which represent a significant fraction of the cost of the product. In central air conditioners and heat pumps, the compressor is the only component that fits those criteria.

In the U.S. four compressor manufacturers offer products for use in residential air conditioners: Bristol (a division of York), Copeland (a division of Emerson Electric), Tecumseh, and Scroll Technologies (a joint venture between Bristol and Carlysle, which itself is a division of Carrier). Bristol and Copeland are the dominant firms. Bristol's product line is limited to reciprocating compressors, which use pistons to compress the refrigerant. Reciprocating compressors have the longest history and have a reputation for reliability. Copeland offers reciprocating compressors, but is known more for its line of scroll compressors. Instead of pistons, scroll compressors use interlocking helixes to compress the refrigerant in a continuous action. Tecumseh and Scroll Technologies are less prominent. Although it offers both types of compressor, Tecumseh supplies mainly reciprocating and rotary compressors in smaller air conditioners and refrigerators. Scroll Technologies is effectively Bristol's scroll division and is capable of supplying only scroll compressors.

Reverse engineering and manufacturer interviews suggested that scroll compressors are currently more popular choices at higher efficiencies. This raises concerns that more stringent standards could provide an advantage to Copeland, the industry leader in scroll compressor sales.

During discussions with the leading compressor suppliers regarding the impacts of new standards and whether new standards would place them at any particular competitive disadvantage, no company we spoke with expressed serious concerns. All companies offer competitive compressors at each efficiency level, and companies are also capable of developing new products to respond to the needs of the market under new standards. They expect the impacts to be proportionate to those on the equipment manufacturers, since the product development costs and process modifications will be of a similar nature. However, they point out that new compressors will have to be available well ahead of the effective date of a new standard to allow equipment manufacturers to incorporate them into air conditioner designs and qualify them for commercial production.

We expect new standards to alter the dynamics of the compressor market, but it is not possible to predict what the changes will be. There certainly will be viable competitors under any scenario who will possess only limited power to impact prices. Even if one company comes to dominate domestically, overseas firms can exert pricing pressure. Therefore, we do not expect new standards to significantly alter the pricing or availability of compressors.

8.6 OTHER IMPACTS

8.6.1 Employment

Manufacturers generally stated that they consider direct labor costs to be related proportionally to materials cost on a per unit basis. Therefore, assuming constant wages, they would expect employment levels to scale with the cost of materials for the industry. We incorporated this assumption into the GRIM, which projects labor expenditures annually. Labor expenditures are a function of the labor intensity of the product, the sales volume, and an implicit wage assumption that remains fixed over time. Table 8.37 provides the changes in labor that would result using that assumption for the three efficiency scenarios as projected by the GRIM. Labor is measured as cumulative change in labor expenditures from 2000 through 2030 versus the base case for each scenario.

Table 8.37 Projected Change in Cumulative Labor Expenditures in the Air Conditioner Industry 2000 - 2030

Efficiency Scenario	Relative Cost Scenario	Trial Standard Level			
		1	2	3	4
NAECA	ARI Mean	10%	21%	25%	38%
	Reverse Engineering	7%	16%	19%	28%
ROLLUP	ARI Mean	8%	19%	23%	36%
SHIFT	ARI Mean	12%	26%	31%	44%

Based on these results, we would expect employment among air conditioner manufacturers to increase roughly in proportion to the increase in minimum SEER. Assuming base employment related to air conditioner and heat pump production of 1,424[2] in 2000, minimum expected job

[2] From reverse engineering: $17.18 fully burdened hourly wage; 240 operating days per year;2 shifts per day plus 50 percent indirect labor of direct labor. From GRIM: $141 million in labor expenses in 2000. Direct and Indirect Employment = $141 million/(240 days /yr x 2 shifts per day x 8 hrs/shift) / ($17.18 x 150%) = 1,424 employees.

creation is 7 percent (100 employees) under TSL1 and maximum potential is 44 percent (342 employees) under the TSL4 Shift scenario. This conclusion is independent of any conclusions regarding employment impacts in the broader U.S. economy.

8.6.2 Production Capacity

Several trends in residential construction have converged recently to produce a surge in air conditioner and heat pump sales. Most manufacturers told us they are nearing their capacity constraints and would plan to add capacity in response to a new standard. The new standards will not obsolete existing production facilities or equipment. Some tooling may become obsoleted, but manufacturers will attempt to transition to new tooling in accordance with their normal retooling cycle.

More stringent efficiency standards, to the extent that they cause an increase in coil size, will somewhat reduce plant throughput, particularly for those plants that are constrained in their coil-shop. In an attempt to recoup capacity, manufacturers will make investments in productivity or equipment, or consider outsourcing some coil production. The five-year planning horizon associated with the new efficiency standard will allow manufacturers to have these solutions ready by the time the new standard goes into effect.

It is not clear that all new capacity will be added in the United States. Some manufacturers stated that more stringent standards will tend to result in the addition of some new capacity outside of the country. This would occur if companies decided that they could free-up capacity in domestic plants by moving export production elsewhere, or if they found that new plants outside of the U.S. could be built and operated more cost effectively.

8.6.3 Exports

Unitary air conditioner and heat pump exports comprise about 4 percent of unitary air conditioner sales, and about one-quarter of that flows to Canada. Although split and packaged equipment popular in North America is used far less in the rest of the world, a few major manufacturers look to foreign markets, particularly Latin America and the Middle East, as a source of revenue growth. Nations in those regions do not require products to meet minimum efficiency requirements. Therefore, as the U.S. efficiency standard increases, baseline domestic air conditioners become less and less like export air conditioners. As manufacturers find that synergies between the domestic and export product lines diminish, manufacturers have less incentive to continue to produce export products domestically. They may decide to reduce their emphasis on the export market, or to build or buy production capacity outside of the U.S. to supply those markets. If the actual sale of U.S. air conditioners to foreign markets decreases as a result of the new standard, there will be a negative effect on company revenues that the GRIM does not capture since the GRIM only considers domestic shipments.

8.6 CUMULATIVE REGULATORY BURDEN

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden.

Companies that produce a wider range of regulated products may be faced with more capital and product development expenditures than their competitors. This can prompt those companies to exit the market or reduce their product offerings, potentially reducing competition. Smaller companies can be especially hard hit since they have lower sales volumes over which to amortize the costs of meeting new regulations. If multiple regulations drain the resources of companies across an industry, industry value can be reduced. That can make the industry more susceptible to foreign competition and reduce the attractiveness of investing in the sector.

The Department considers that a proposed standard is not economically justified if it contributes to an unacceptable cumulative regulatory burden.

8.6.1 Federal Regulations on Central Air Conditioners and other Products Produced by the Same Manufacturers

In addition to the efficiency regulations on residential air conditioners, several other federal regulations and pending regulations apply to central air conditioners and other products produced by the same manufacturers. The most significant of these are the EPA-mandated phaseouts of HCFCs. Table 8.38 provides the timetables for these regulations. In addition to those listed, the DOE has lower priority plans to reassess efficiency standards for residential furnaces and boilers.

Table 8.38 Summary of Major Regulations on Central Air Conditioner Manufacturers

Regulation	Key Affected Appliances	Effective Date
Residential appliance energy efficiency requirements (DOE)	Room air conditioners	October 1, 2000
	Refrigerators/freezers	July 1, 2001
	Water Heaters	January 2006*
EPA ban on new equipment using HCFC refrigerants	Room and central air conditioners, commercial air conditioners, refrigerators, freezers	January 1, 2010
EPA ban on HCFC-141b foam blowing agent	Water heaters, refrigerators, freezers	January 1, 2003
Consumer Product Safety Commission prompted voluntary standards for flammable vapor ignition	Water heaters	imminent
EPA standards on emissions of allowable hazardous air pollutants from the coating of large appliances (NESHAP/MACT standards, Clean Air Act Section 112(d))	Central air conditioners, refrigerators, freezers, furnaces	October 2004*
DOE adoption of ASHRAE 90.1-1999 energy efficiency standards for new commercial buildings	Unitary and applied air conditioners, furnaces, boilers	2003 – 2005

* anticipated effective date

Table 8.39 lists the market shares of major air conditioner manufacturers subject to the regulations listed in Table 8.38. High market shares imply that the companies will bear a significant portion of the burden of the regulation.

Table 8.39 Market Shares of Major Air Conditioner Manufacturers in Regulated Products

	Carrier	Goodman (including Amana)	Rheem	Lennox Nordyne Trane York	Others	Total All Air Conditioner Manufacturers
Residential Central Air Conditioners	31	19	13	34	3	100
Room Air Conditioners	3	7				10
Residential Water Heaters			27			27
Residential Clothes Washers and Dryers		5				5
Residential Refrigerators		9				9

Source: Appliance Magazine, September 1998.

Since we have not obtained market share estimates for commercial products covered by the ASHRAE 90.1 standard, we did not include them in Table 8.39. However, Carrier, Lennox, Trane, and York all participate extensively in the market for applied heating and cooling equipment.

In residential products, the overlap between companies who produce central air conditioners and other regulated products is small except in the case of water heaters. Two companies, Rheem and Goodman, face the greatest cumulative burdens. Rheem holds a leading position in the supply of residential water heaters which are subject to a forthcoming EPA ban on the foam blowing agent HCFC-141b, a DOE rulemaking which would raise their energy efficiency requirements, and a Consumer Product Safety Commission requirement to adhere to voluntary standards regarding the ignition of flammable vapors. Goodman is in a slightly different but similarly burdensome situation. Goodman's Amana division produces and sells a broad line of residential appliances. Refrigerators, room air conditioners, and clothes washers will all be impacted by forthcoming increases in energy efficiency requirements, and Amana's refrigerators will be subject to the ban on HCFC-141b.

Table 8.40 indicates the level of impacts that the central air conditioning industry may face due to other federal regulations that will become effective over the next ten years. The estimated investment for the air conditioner industry in each category is the product of the total industrial expenditures in the category and the total market share of air conditioner manufacturing companies presented in Table 8.39. The projection exceeds $479 million, mostly related to the phaseout of HCFC-22.

The uncertainty surrounding these values is high for several reasons. First, manufacturer impacts depend largely on the company's ability to pass conversion costs through to consumers. Second, information on capital expenditures, R&D, and other conversion costs and project plans are usually considered confidential. Third, companies may be able to incorporate regulatory-driven expenditures into other product development or process improvement efforts.

Table 8.40 Estimated Investments Required to Meet Impending Federal Regulations ($ million)

	Total Investment by All Manufacturers	Estimated Investment Incurred by Central Air Conditioner Manufacturers	Source of Estimate
HCFC-22 ban	n/a	$350	Interviews with central air conditioner manufacturers
HCFC-141b ban–water heaters	$15	$4	DOE water heater efficiency rulemaking
HCFC-141b ban–refrigerators	?	?	No estimate
Flammable Vapor Ignition	$95	$25	Water heater consortium estimate
Refrigerator/Freezer Efficiency	$500	$45	Estimated investment in DOE rulemaking analysis
Room air conditioner efficiency	$8	$1	Estimated investment in DOE rulemaking analysis
Water Heater Efficiency	$61	$13	DOE water heater efficiency rulemaking
Clothes Washer Efficiency	$823	$41	DOE clothes washer efficiency rulemaking
NESHAP/MACT	?	?	No estimate
Total All Regulations		$479+	

The most significant regulation facing the central air conditioning industry is the ban on new equipment utilizing HCFC-22. Manufacturers of residential air conditioners also engage in the production and sale of commercial air conditioners, chillers, and refrigerators, all of which will require some conversion to an alternative refrigerant by 2010. For residential air conditioners, conversion to 410A requires new design and certification, testing, production equipment and processes, and tooling. Since HCFC-22 has been the dominant refrigerant for decades, companies must develop a wealth of new knowledge and experience. The level of expenditure required to convert all production of residential equipment to 410A is expected to be on the order of $50 million per company. This is comparable to what we have assumed would be the expenditures related to converting to a 13 SEER efficiency standard. To the extent that manufacturers can introduce new products utilizing the new refrigerant and meeting the new efficiency standard, the cumulative burden will be reduced.

The EPA's pending NESHAP/MACT regulations impact primarily the painting, or surface coating, of air conditioners and other large appliances. They will establish a standard for the emission of hazardous atmospheric pollutants for a facility based on the maximum achievable control technology as displayed by the facility's peers. Some air conditioner facilities may have trouble meeting the new requirements and could incur significant investments. The EPA plans to publish estimates of industry impacts prior to establishing its final rule. Any new regulation will likely become effective three years after the publication of the rule, which is scheduled for October 2001 according to EPA's website.

8.6.2 Pending Regulations and Regulations at the State Level

Manufacturers also identified several regulations which are either under consideration or will be imposed at the state level. These include:

- Compliance with the International Standards Organization (ISO) testing procedures for air conditioners, which will likely require duplicate testing and certification for products
- Performance or prescriptive standards set at the state level, which include a proposed requirement in Texas that all new commercial and residential air conditioning units installed in Central and East Texas reduce the ground level ozone in air passing through the units by at least 70 percent through the use of new technology, starting in 2002.
- State level safety regulations

Of these, the proposed Texas requirement is of the highest concern to manufacturers who claim that the technology under consideration is unproven, reduces equipment efficiency, is potentially toxic, and would add as much as $1,000 to the cost of a new air conditioner. Most of all, manufacturers are concerned that if states begin to establish separate standards, they will have to design, develop, test, certify, and produce separate products for each market, largely reversing the economies of scale that the manufacturers currently obtain by producing a single product that can be sold anywhere in the United States. ARI believes the total required investment by industry could exceed $1 billion.

8.7. CONCLUSIONS

8.7.1 Trial Standard Level 1 (TSL1)

Impacts on manufacturers due to TSL1, which would require all products to meet an 11 SEER standard, are modest. Even though over 70 percent of products will no longer meet the new standard levels, the differences between 10 SEER and 11 SEER products are slight, and all manufacturers and subgroups should be able to respond with viable, reliable, and competitive product without facing a severe strain on capital or cash flow. Furthermore, manufacturers will continue to be able to differentiate their products and induce consumers to “buy up” to products at the 12, 13, and 14 SEER levels, allowing companies who depend on such sales to retain their profitability. Industry value will lower only slightly, and could actually increase since the Shift efficiency scenario has a good chance of occurring. Additionally, all niche products should be able to satisfy TSL1 using conventional technologies.

8.7.2 Trial Standard Level 2 (TSL2)

Eighty-one (81) percent of products currently sold would not meet the requirements of TSL2, which would require all products to meet a 12 SEER standard. We estimate that current 12 SEER products generate 30 percent of the industry’s profits. Under TSL2, the 12 SEER product would be required to compete primarily on price rather than premium features, resulting in the loss of those profits, and a corresponding reduction in industry value. Manufacturers who emphasize baseline equipment would benefit slightly under TSL2. Those manufacturers whose profits depend more substantially on the sale of 12 SEER equipment, however, would have to look to the 14 SEER level, or higher, to retain their profitability. Since 14 SEER is quite near the technical limit of efficiency for products sold without a blower (comprising half of all sales), they may find it difficult to provide enough value to consumers in those products to duplicate their current 12 SEER sale volumes. The same is true for non-modulating, single speed systems at 14 SEER. Under these conditions, the Roll-up efficiency scenario becomes possible.

In an attempt to ward-off the Roll-up scenario, higher operating cost manufacturers faced with TSL2 would have the incentive to develop a new generation of single speed, non-modulating products at and above 14 SEER in an attempt to retain their profitability and differentiation. These products would likely rely on conventional technologies, but should also provide an impetus to deploy the microchannel heat exchanger and new technologies that improve heat transfer and steady-state compressor efficiency. If that outcome occurs, impacts could resemble the NAECA or even the Shift scenarios, with burdens less than half as severe as the Roll-up scenario. The NAECA scenario is the most likely outcome, resulting in a loss of industry value on the order of $200 million.

Some manufacturers in the higher operating cost subgroup, because of lack of financial or technical resources or competitive advantage, would choose not to attempt the development of new 14 SEER products. Instead, they would focus on operating and production cost reductions and seek to retain their profitability at the 12 SEER level.

Manufacturers of through-the-wall condensing units would find it quite difficult to meet TSL2 without additional infusions of capital and considerable development expenditures. Other niche product manufacturers will likely be able to sustain their sales volumes and revenues.

TSL2, because of the larger refrigerant charges required, would likely hasten the introduction of products based on HFCs to avoid exceeding the federal cap on HCFC-22.

8.7.3 Trial Standard Level 3 (TSL3)

TSL3 retains the 12 SEER standard requirements from TSL2 for cooling-only equipment, but requires heat pumps to meet a 13 SEER standard. Approximately 95 percent of heat pumps currently sold would not meet TSL3. However, since heat pump products comprise only 25 percent of all products sold, several manufacturers may choose to discontinue or drastically trim their heat pump product lines rather than invest in the production capacity and product development required to supply heat pumps under the new standard. Aside from that possible outcome, the impacts on major manufacturers of TSL3 are expected to be generally similar to those of TSL2.

All niche product heat pumps evaluated, except through-the-wall packaged units built for new construction, would find it nearly impossible to meet the new heat pump requirements with conventional technologies and still expect to retain sales volumes necessary to sustain their profitability.

8.7.4 Trial Standard Level 4 (TSL4)

Ninety-seven (97) percent of the products currently sold would not meet the standards required by TSL4. That represents a serious discontinuity for an industry whose product development and marketing revolve around product efficiency levels. Manufacturers would be required to invest in new production capacity, develop new marketing strategies and products, and perhaps transition to new business philosophies. It is highly unlikely that manufacturers would be able to develop products at the 15 or 16 SEER levels that would offer the incremental value to consumers that 12 SEER products offer to consumers under the current 10 SEER standard. The Roll-up scenario, therefore, is quite likely to occur with a resulting loss in industry value of something on the order of $360 million. Several major companies would likely consider selling their production assets rather than making the investment required to meet the new standard or facing the loss of profitability associated with the absence of viable premium and higher efficiency products. A large reduction in the number of firms in the market would raise concerns about a reduction in competition, although it is likely that enough competitive companies would remain to prevent any of them from being able to control prices.

It is highly unlikely that any niche product would be technically able to attain TSL4. Small manufacturers engaged in the production of conventional equipment would find it difficult to overcome the financial and technical burdens associated with the transition, and could decide to exit the market.